REPORT OF
THE REVIEW COMMITTEE
ON
T-GRADUATE EDUCATION & RESEARCH
IN
ENGINEERING & TECHNOLOGY

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MINISTRY OF
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REPORT OF THE REVIEW COMMITTEE ON POST-GRADUATE EDUCATION AND RESEARCH IN ENGINEERING AND TECHNOLOGY

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GLOSSARY OF ABBREVIATIONS

1.	AICTE	All India Council for Technical Education
2.	BHU-IT	Banaras Hindu University-Institute of Technology
3.	BITS	Birla Institute of Technology and Sciences
4.	CSIR	Council of Scientific and Industrial Research
5.	CSIO	Central Scientific Instruments Organisation
6.	DGS&D	Directorate General of Supplies and Disposals
7.	DST	Department of Science and Technology
8.	FICCI	Federation of Indian Chambers of Commerce and Industry
9.	FRG	Federal Republic of Germany
10.	GNP	Gross National Product
11.	GATE	Graduate Aptitude Test in Engineering
12.	HBTI	Harcourt Butler Technological Institute
13.	IBM	International Business Machines
14.	IISc	Indian Institute of Science
15.	IIT	Indian Institute of Technology
16.	INSDOC	Indian National Scientific Documentation Centre
17.	ISI	Indian Standards Institution
18.	ISM	Indian School of Mines
19.	MIT	Massachussetts Institute of Technology
20.	NCST	National Committee on Science & Technology
21.	NISSAT	National Information System for Science and Technology
22.	NITIE	National Institute tor Training in Industrial Engineering
23.	PAUT	Perarignar Anna University of Technology

24.	PWD	Public Works Department
25.	QIP	Quality Improvement Programme
26.	R & D	Research and Development
27.	REC	Regional Engineering College
28.	RSIC	Regional Sophisticated Instruments Centre
29.	S & T	Science and Technology
30.	SPA	School of Planning and Architecture
31.	TCDC	Technical Cooparation among Developing Countries
32.	UDCT	University Department of Chemical Technology
33.	UGC	University Grants Commission
34.	U K	United Kingdom
35.	UPSC	Union Public Service Commission
36.	VJTI	Victoria Jubilee Technological Institute

CHAIRMAN'S PREFACE

It is now well recognised that science and technology are catalysts for growth and propellants for progress. It becomes imperative for each country to develop a well-integrated technical education system for sustained growth. Postgraduate education and research are but a normal part of engineering education.

India is fortunate to have the third largest scientific and technical manpower in the world with a large infrastructure for higher technical education, research and development. Yet the fond hope that the fruits of science and technology will diffuse to improve the economic well-being of all people has not materialised: instead the gap has only widened between the urban elite and the rural poor. Obviously there is a mis-match between educational objectives and social needs.

Similarly employment opportunities commensurate with the advanced knowledge and skills of highly trained personnel are still quite limited resulting in unemployment, underemployment and brain drain. There is thus also a mis-match between university products and industry's needs.

It becomes clear that the goal of post-graduate education and research in engineering must include 'development' philosophy to remove the existing imbalances. There is room to believe that an engineer should be trained as a 'practising' engineer in parallel to a practising doctor-or a 'development engineer' with entrepreneural ability. Development is a transdisciplinary process requiring transdisciplinary approach. The individual 'lone-wolf' approach in education and research should give way to transdisciplinary, trans-organisational task force approach to resolve problems.

Similarly the ambivalent attitude of academicians should change towards 'relevance'. Problems of the poor could be equally intellectually challenging and professionally satisfying. Societal problems should be the legitimate concern of engineering and science. Post-graduate institutions must accept 'public service'as one of their primary functions and 'extension service' as a 'third dimension' in addition to training and research.

Presently, neither 'private profit' nor 'public good' is enshrined in higher education. When once the goals of development education are clear and accepted, post-graduate institutions may bring about the much needed changes within and outside the education system. Greater attention has to be paid to curriculum production and utilization of trained personnel and firm linkages between the trinity: industry, research and education.

Today industry's involvement in higher education is limited and the total technical manpower employed is small. It is time for the industry to realise that "to bring less than the most up-todate and powerful engineering skills to bear on the problems of an emerging country is to restrict severely the rate of its technological development. The problems may be old, but they deserve the most modern solutions we can find". Polite persuasion and concealed compulsion are called for to legitimize industry's involvement in post-graduate education and research.

A considered thought is needed on the present and future trends and needs. A sense of urgency has been felt by the Government of India to review the whole system of post-graduate education and research in engineering and technology. This Report has been prepared based on the careful scrutiny of discussions and debates on several documents and reports published, practices obtained within and outside the country, comments and suggestions received from a large number of students, researchers, academicians, educators, industrialists, administrators and policy makers and the cumulative rich experience and wide knowledge of the distingushed members of the Committee. I am particularly grateful to a number of individuals who have shown keen interest in this work and offered valuable guidance.

A number of recommendations made herein are specific and readily implementable. Some require new initiatives. For others the first steps to be taken to achieve identified objectives have been given. Where the issues are highly complex, further detailed studies have been indicated. One important single recommendation linked to many others is that the Government should set up a new statutory organisation-a National Authority-to advance and promote technological developments by maintaining high standards of engineering and technological education and research. The case for such an Authority is a recognition of the need for an organisation accountable for

ensuring action both on this Report and in the light of changing technological and social needs.

It was a privilege for this Committee to work together on this important assignment. I thank all the members for their willing Co-operation and determined efforts and time put in to make this Report possible. No praise is adequate for the drive, dynamism and devotion of the ever enthusiastic Member-Secretary of the Committee Dr. Gopalan.

It is sincerely hoped that this Report would prove interesting to all connected with post-graduate education and research and that the implementation of these recommendations would have positive impacts on the country's Progress.

JUNE 2, 1980.

Sd/- Y. NAYUDAMMA

SUMMARY AND RECOMMENDATIONS

In June 1978 the Government of India appointed the Committee to review the progress so far made by the country in the area of Post-graduate education & research in engineering and technology and to report on all aspects of its further development. In order to fulfil the task assigned to it, the Committee collected relevant information from almost all institutions offering Postgraduate programmes, held extensive discussions with students, teachers, academicians, industrialists, researchers, administrators etc. in various parts of India, consulted a large number of documents and reports and also looked into the trends and practices in other parts of the world. This report is based on all these discussions and exercises. While bringing to focus the major issues, problems and suggestions relating to post-graduate education & research, the report also points out some of the limitations the Committee had. The main findings and recommendations are briefly summarised below for quick reference:

(1) While there has been considerable expansion of the system of post-graduate education & research in the country during the past three decades, and it has done quite a lot of good to national development, the shortcomings in the implementation of the recommendations made by the earlier reviews have been responsible for many of its ills today. Post-graduate education & research is a matter of national concern and therefore should get continuous and serious attention on a priority basis. (2.1, 2.5, 3.8.4, 5.1 and 5.2).

(2) Today the S & T content in the Indian society and the extent of India's involvement in R & D are very low. The capacity for generating and sustaining technological growth within the country has to be strengthened considerably and vigorous steps taken for the continual improvement of that capacity. This means that the Indian national investment in scientific and technological education and research should increase many fold to meet the growing needs of the changing social system, (4.1.2, 4.1.5, 4.13.5, 5.4 and 5.6).

(3) The performance of about half-a-dozen institution inthe area of Post-graduate education and research has been quite good mainly because of

the deliberate efforts and liberal investments in promoting them. In spite of the considerably lower inputs, about 20 other institutions have also done creditably well. The performance of the remaining 50 or so institutions is poor, even though they also have succeeded in developing certain areas/disciplines well. The physical facilities in many of these institutions are inadequate (3.1-3.8 and 5.5).

(4) For a variety of reasons, it has not been possible to attract sufficiently large number of bright people for post- graduate education. To ensure that only bright and motivated people are admitted to Post-graduate courses, admission to these programmes should be restricted to only those who come through the GATE, as detailed in this report. The Government should impose requirements on industry and Government departments to sponsor their engineers and technologists for post-graduate education & research in the respective areas of their interest (4.4.3 and 4.14.3).

(5) Post-graduate scholarships for ME/M Tech should be enhanced from the present value of Rs. 400/- p.m. to Rs. 600/-p.m. and should be given to all those who are admitted through the GATE. However, sponsored candidates who are paid by their employers would be eligible to get only75 % of the value of the scholarship.

Fellowships for doctoral aspirants should be raised from the present value ol Rs. 500/-p.m. to: first year Rs. 700/-p.m.; second year Rs. 800/- p.m. and third year Rs. 900/-p.m. The fellowship should be enhanced by Rs. 50/- after submission of the thesis and should be continued for 3 more months or till the 'viva' is over, whichever is earlier. Values of all scholarships/ fellowships should be reviewed once in every 3 years (4.4.3 and 5.9).

(6) The one-year post-graduate diploma courses have not been found to be popular and successful. They need not be offered as regular programmes unless they are specifically asked for and paid for by interested agencies (4.2.2, 4.5.1, 4.5.2 and 5.10).

All existing post-graduate degree programmes which are out-dated, stereotyped and unpopular should be wound up. Wherever possible they should be redesigned to include relevant and emerging areas (4.4.3, 4.6 and 5.11).

All ME/M Tech. programmes should be of three semesters duration consisting of two semesters course work (including core and elective subjects) and one semester dissertation work.

The concept of joint guides for supervising project / dissertation work should be encouraged. These programmes should be offered in suitable modules with credit system. Post-graduate Curriculum Development Centres should be set up to revise, redesign and update the curricula of Post graduate programmes on a continuing basis. The curricula, should be dynamically designed and should have flexibility to include new ideas and developments as and when necessary (3.2, 4.3, 4 5 2, 4.5.3, 5.12 and 5.13,)

The minimum duration for doctorate after ME/M Tech. degree should be two years of full-time study and research. In exceptional cases when BEs/B Techs are admitted directly for doctoral programmes, the minium duration of the course should be 3 years. All aspirants for doctorate should invariably go through some advanced course relevant to the specific area of research. 'Candidate-based Doctoral Committees' should assess the candidate's competence and identify his deficiencies (4.5.5, 4.10.5 and 5.14.)

In many emerging areas which are science-based, but heavily technology oriented, there is need to train scientist-technologists who can handle the twin responsibilities of scientific research and innovative application. A separate stream of post-graduate courses of 3 semesters duration after MSc in science should be developed on the pattern of ME / M Tech. programmes (4.15.1 — 4.15.4 and 5.15.)

Under no circumstances should further proliferation of existing programmes in conventional or irrelevant areas be permitted. Neighbouring academic and research institutions should be encouraged not only to conduct post-graduate programmes jointly, but also to share jointly the facilities such as faculty, library, equipment etc. (4.7.1, 4.7.2 and 5. 16.)

(7) Introduction of part-time post-graduate programmes especially in Industrialised areas should be encouraged. New techniques and arrangements should be devised for extending high quality post-graduate education to engineers / technologists employed at locations remote from established cam. puses (4.16.1 — 4.16.3, 5.17 and 5.18.)

The Government and industry should work together within a major national programme of training and retraining of employed engineers and technologists to develop the skills and support needed to implement and sustain new technologies. While assessing staff requirements of institutions, their activities in continuing education programmes should also be taken to account (4.17.1, 4.17.5, 5.19 and 5.20.)

(8) It is necessary to recognise publicly and to publicise widely that in today's world post-graduate studies at master's degree level are a normal part of basic engineering education. The unreasonably restrictive conception that a bachelor's degree is sufficient preparation for most engineering work should not be perpetuated (4.2.1, 4.22 and 5.21.)

It should be made mandatory to prescribe post-graduate degree as the minimum qualification for recruitment to many positions in the engineering profession in industry, R & D organisations, Electricity Boards, PWDs, Post and Telegraphs, Railways etc. The present policy and practice of recruiting graduate engineers at the lowest levels (single point entry) to many services should be discontinued. As an incentive and mark of recognition it should be mandatory to give not less than 2 advance increments whenever post-graduate degree holders are recruited (4.2.3 and 5.22.)

The Government should take effective measures to link up all developmental projects and industrial expansion with the requirement of induction of competent post-graduate engineers and technologists into the respective projects. Industrial establishments should be asked to institute regular 'engineering manpower audits' to ensure that they make the best use of these personnel as their key assets. Proper utilisation and deployment of scientific and technical manpower are important (4.20.1, 4.20.5, 4.18.5 and 5.23.)

A reliable national information system for the storage, updating, retrieval and analysis of manpower information should be established to assist technical education planning (1.4.4, 4.21 and 5.24.)

It is necessary to study the employment pattern of post-graduates in industry, Government, education etc. and also to make inter-comparisons regarding their characteristics, attitudes and performance (1.4.5 and 5.25.)

(9) Next to the student body, the faculty is the most important factor n assuring success of any engineering education programme. Possession

of a doctorate degree or equivalent qualification representing an advanced level of intellectual attainment and creative endeavour should be made a pre-requisite for post-graduate teaching. Industrial experience should be prescribed as an essential qualification for recruitment to teaching positions at post-graduate level. All recruitments to teaching positions should be made only on all-India basis. Mobility and exchange of faculty belween academic institutions, R & D organisations and industrial establishments should be encouraged to prevent in-breeding, (4.8.1 — 4.8.3, 5.26 and 5.27.)

A rigorous 'staff appraisal scheme' to assess teachers annually should be introduced in every post-graduate institution. Such staff appraisal records should be looked into at every stage of promotion. Suitable merit promotion schemes should be introduced in all institutions (4.8.4, 4.85 and 5.28.)

(10) It is necessary to create in some of the higher technological institutions an infra-structure for training in the instrumentation area with particular reference to repairs and maintenance of sophisticated equipment. Institutions like IITs should ensure that they are capable of maintaining and repairing their own equipment and those of others in their region. A specialist cadre of maintenance technicians/engineers with proper status and attractive scales of pay should be built up atleast on a regional basis (4.6, 4.9.1,4.9.6, 5.29 and 5.30).

(11) Government should impose requirements on industry as well as on post-graduate institutions to collaborate with each other on the basis of the various suggestions made in this report. The tendency on the part of industry to look to the advanced countries for technical know-how should be discouraged. Tax should be levied on any know-how imported from outside. A research cess should be levied (if necessary through legislative action) on each industry. A 133% tax deduction should be allowed on all payments/contributions/investments made by industry to promote post-graduate education and research (3.5, 4.3, 4.10, 4.14 and 5.33).

(12) There is urgent need to take deliberate action to prevent enormous wastage of resources on repetitive and irrelevant reasearch projects. Academic research at all levels should emphasise work done in the context of socio-economic development. The culture of sponsored research projects should be further developed (4.10.1-4.10.3).

Institutional consultancy should be encouraged and individual consultancy permitted on the basis of predetermined norms. The money earned from sponsored and consultancy projects should be utilised for further developing the research capability of the institutions (4.10.3, 4.10.4, 4.14.3, 5.35 and 5.36).

Multi-disciplinary, trans-disciplinary and trans-organisational research with emphasis on design and development should be encouraged at all levels. Problems of industry should be documented and distributed to post-graduate institutions on a continuing basis. It is recommended that a national level R & D Newsletter should be published regularly giving information on all research projects for the benefit of post-graduate institutions, R & D organisations and industry. It would be good to organise atleast once in every two years an all-India Conference on post-graduate projects and to document them area/discipline-wise. (4.4, 4.10.5, 4.10.6, 4.14.3 and 5.37).

Those institutions which have competence to undertake sponsored research projects on a large scale should be permitted to recruit a core of competent scientific staff on permanent basis with all service benefits (4.10.4, 4.11.1, 4.11.2, and 5.38).

(13) Immediate action should be taken to revise the norms of funding to provide physical and other facilities in post-graduate institutions on the basis of guidelines suggested in this report. The recommendation of grants for new post-graduate programmes should be based on the overall post-graduate activities of the departments concerned and not a narrow truncated basis of specific post-graduate courses proposed by an institution (4.12.6 and 5.40).

While it is necessary to undertake in a phased manner the need-based consolidation of all institutions (including modernisation of laboratories and replacement of obsolete equipment), it is strongly recommended that such consolidation be undertaken on a priority basis in those institutions which-despite poor funding-have proved their merit by their past performance. These institutions should serve as nuclei for technological development in their respective regions. A provision of about Rs.20 crores may be made available for this purpose during the Sixth Plan period (1980-85) (4.12.7 and 5.41).

It is imperative that funding post-graduate education and research in engineering and technology in all engineering institutions including University Departments should be a 100% Central Government responsibility and that the existing dichotomies/disparities in funding should be eliminated. as suggested in this report (4.13.1-4.13.6, 4.18.5 and 5.42)

In the case of institutions of national importance which are to be maintained and further developed as pacesetters, funding should be based on integrated infrastructural development as at present. However, even in their cases assistance to various departments should be performance -based (4.13.7 and 5.43)

Since non-Plan provisions have been approved from 79-80 for meeting the recuring liability in respect of on-going post-graduate programmes, the Central Government should advise the State Governments to extend retirement and other service benefits to post-graduate staff in institution which are governed by the State Government grant-in-aid rules (4.12.5 and 5.44)

(14) One of the biggest stumbling blocks in the path of scientific and technological research and development in India is the lack of proper data banks/information services. There is immediate need to educate and train information users by introducing user education/training programmes in the post graduate institutions and Research Centres (4.19.1 - 4.19.3 and 5.45).

India is importing bibliographical data bases along with appropriate software to develop computerised information retrieval system in the country. It is necessary to absorb this imported 'information technology' and develop it further to suit local needs (4.19.4, 4.19.5, and 5.46).

It is strongly recommended that a couple of National Data Centres with all the major data bases of S & T in the form of computer readable magnetic tapes should be established in India as a matter of urgency, (4.19.6, 4.19.7 and 5.47).

(15) This Committee's most important single recommendation linked to many other proposals in various sections in this report is that the Govennment should make the AICTE/Post-graduate Board a new statutory organisation-a National Authority-with powers granted to it by Parliament to advance and promote the technological development of this country by

maintaining high standards of engineering and technological education and research. The proposed Authority should optimise the utilisation of all available resources and provide impetus to all the centres engaged in Post-graduate programmes and research. Evaluation and accreditation of Post-graduate courses should be done atleast once in five years by a suitable national agency (2.4.2, 4.18.4 - 4.18.7, 4.20.2 and 5.48 - 5.50).

Methods should be developed for the performance-based audit of Post-graduate institutions with a view to facilitate comprehensive reviews of their various programmes. The present system of financial expenditure audit should be replaced (4.18.8 and 5.51).

(16) India has a leading role to play in the new concept of TCDC. In her own interest India should formulate a coherent 'country training policy' for training overseas students in emerging areas of engineering and technology (4.22.1, 4.22 2, and 5 52).


सत्यमेव जयते

REPORT OF THE REVIEW COMMITTEE ON POST-GRADUATE EDUCATION AND RESEARCH IN ENGINEERING AND TECHNOLOGY

1.0 PREAMBLE

1.1 Appointment of the Committee

1.1.1 In any country scientists, engineers, and technologists are an important national asset. They provide instruction and training in the various fields of Science and Technology (S & T), conduct basic research to advance the understanding of nature and perform effective research and development (R & D) in a diversity of areas encompassing every hurnan endeavour. In addition, persons trained in science, engineering and technology are employed throughout the economy — from industrial management to agricultural production—to provide the knowledge and skills which are essential in a technologically advancing society. The role of scientists, engineers and technologists in helping to meet the changing needs of the country, coupled with the extended time and high cost involved in their training, requires that continuous attention be given to trends and patterns in the production of such personnel.

1.1.2 Reviews of post-graduate education and research in engineering and technology have been undertaken in the past and these are mentioned in this report (2.0). The present Review Committee was appointed in June 1978 on the basis of a suggestion made by the Expenditure Finance Committee (of the Government of India) and on the recommendation of the Board of Post-graduate Engineering Studies and Research (hereafter called Post Graduate Board) of the All India Council for Technical Education (AICTE). The Committee was consitituted in consultation with the Department of Science and Technology (DST) and the University Grants Commission (UGC). In the course of its work the Committee co-opted a few members while a couple of others resigned from the Committee since they could not spare time for this work. The composition of the committee as at present is :

1. Prof. Dr. Y. Nayudamma, Chairman
(Former Director-General, CSIR & Secretary to the Government of India),
Distinguished Scientist,
Central Leather Research Institute,
Madras-600 020,

2. Prof. Dr. C S. Jha.
Educational Adviser (T),
Ministry of Education & Culture,
New Delhi-110 001.

3. Prof. Dr. B. Ramachandra Rao,
Vice-Chairman,
University Grants Commission,
Bahadurshah Zafar Marg,
New Delhi-110 002.

4. Prof. Dr. M. M. Sharma,
Department of Chemical Technology,
University of Bombay,
Bombay-400 019.

5. Shri Kan D. Mariwalla,
Chairman & Managing Director,
The National Industrial Development Corporation Ltd.
Chanakya Bhavan,
New Delhi-110 021.

6. Dr. S. Varadarajan,
Chairman & Managing Director,
Indian Petro-Chemicals Corpn. Ltd.,
10th Floor, Ashoka Estate,
24, Barakhamba Road,
New Delhi-110 001.

7. Shri F. C. Kohli,
Tata Consultancy Services,
Air India Building,
Nariman Point,
Bombay-400 021.

8. Shri J.H. Doshi,
Amar Dye-Chem. Ltd.,
Rang Udyan,
Sitladevi Temple Road,
Mahim,
Bombay-400 016.

9. Prof. Dr. Jagdish Narain,
Vice-Chancellor,
University of Roorkee,
Roorkee-247 672.

10. Prof. Dr. A.K. De,
Director,
Indian Institute of Technology,
Bombay-400 076.

11. Prof. Dr. Shankar Lal,
Director,
Indian Institute of Technology,
Kharagpur-721 302.

12. Dr. V. S. Arunachalam,
Director,
Defence Metallurgical Research Laboratory,
Hyderabad-500 258.

13. Prof. Dr. T. R. Anantharaman,
Department of Metallurgical Engineering,
Institute of Technology,
Banaras Hindu University,
Varanasi-221 005.

14. Prof. Dr. G. S. Ladha,
Director,
A. C. College of Technology,
Madras-600 025.

15. Shri J. A Kalyanakrishnan,
Financial Adviser,
Ministry of Education & Culture,
New Delhi-110 001.

16. Shri B. Sinha,
Joint Secretary,
Department of Power,
Ministry of Energy,
Oorja Mantralaya,
New Delhi-110 001.

17. Prof. Dr. K. Koteshwara Rao,
Principal,
Regional Engineering College,
Warangal-506 004.

18. Prof. Dr. G. N. Garud,
Department of Electrical Engineering,
Visvesvaraya Regional College of Engineering,
Nagpur-440 011

19. Shri A. S. Sekhon,
Institution of Engineers (India),
Punjab, Haryana and Himachal Centre,
Sector 19,
Chandigarh.

20. Dr. K. Gopalan, Member — Secretary,
Deputy Educational Advisor (T),
Ministry of Education & Culture,
New Delhi-110 001.

It will be seen that the Committee had on it representatives of industry (both private and public sectors), R & D organisations, University Grants Commission, Federation of Indian Chambers of Commerce and Industry, Institution of Engineers (India), Government departments, and educational institutions belonging to various categories.

1.2 Terms of reference :

The Committee was given the following terms of reference:

(1) To evaluate the progress made so far in the development of Post-graduate courses and research in engineering and technology.

(2) To review the post-graduate programmes in university departments, Indian Institutes of Technology (IITs) and other affiliated colleges and to recommend discontinuation of post - graduate courses which are not relevant to the national needs and to recommend areas of emerging interests for which post-graduate courses may be organised.

(3) To recommend the norms and pattern of assistance for post-graduate courses in respect of university departments, IITs and affiliated colleges.

(4) To examine advisability of concentrating postgraduate courses in selected institutions for better progress.

(5) To consider the manner of achieving close coordination of post-graduate training and research with the major developmental and engineering schemes of the country.

(6) To report on all other aspects of improvement and development of post-graduate courses.

1.3 Methodology adopted:

1.3.1 At its first meeting held on 21-8-1978, the Committee discussed the methodology to be adopted to carry out the tasks assigned to it. A questionnaire was evolved (Annexure I) to collect information on all relevant aspects of Post-graduate education and research from all institutions offering Post-graduate programmes. It was resolved to visit as many institutions as possible and also to hold discussions with industrialists, academicians, educators, research scholars, Post-graduate students, educational administrators, representatives of R & D organisations and others concerned with Post-graduate education and research in various parts of India.

1.3.2 Accordingly, the Committee collected information from almost all institutions offering Post-graduate programmes. It held meetings at Delhi

Bombay, Ahmedabad, Calcutta, Kanpur, Hyderabad, Coimbatore, Madras and Bangalore. At all these places the Committee visited the local institutions and also exchanged views with those concerned with Post-graduate education and research including teachers and students, representatives of industry and R & D organisations, etc. Many who met the Committee subsequently transmitted their views to the Committee in writing. These views varied from short notes to articles of book length.

Some members of the Committee visited institutions in their respective regions and fed the Committee with relevant information.

1.3.3 The Committee also invited the views and suggestions of all interested in and concerned with post-graduate education and research through advertisements in all important national newspapers. The response was remarkably good.

1.3.4 At its sessions in Delhi, the Committee spoke to the concerned Secretaries to the Government of India and other senior officials who are directly responsible for the administration of R & D organisations, post-graduate institutions, etc. These discussions were very useful.

1.3.5. The Committee also consulted a large number of documents and reports on the subject and also looked into the trends and practices in other countries. A list of some of these documents is placed at Annexure II.

1.3.6 In april 1980, before finalising the report, the Chairman of the Committee had discussions with some of the senior policy makers in the Government of India including all the three members of the Planning Commission.

1.3.7 This report is based on all these discussions and a series of studies carried out during the past 2 years involving the accumulation of a large mass of data from engineering educators, practising engineers and employers of engineering talent throughout India. The comments received together with the basic data accumulated have been digested and analysed in an effort to fulfil the charge placed on the Committee.

1 3 8. The Committee wishes to place on record its gratitude and thankfulness to the numerous agencies and individuals who showed keen

interest in its work and also gave their views and suggestions for its consideration. The courtesies and hospitality extended to the Committee by various organisation and institutions when it met at various parts of India are also gratefully acknowledged.

1.4 Limitations of the report

1.4.1 As mentioned above, this report has been prepared on comments and suggestions received from literally hundreds of engineers, engineering educators and other individuals and groups concerned with post-graduate education and research. On many issues, the Committee found a wide diversity of evidence and even more of opinion. The Committee has made a determined effort to delineate the significant trends in post graduate education and to relate these trends to the future needs of the country.

1.4.2 It was not possible for the Committee to visit all the 74 institutions offering Post-graduate programmes in engineering and technology or to evaluate the various Post-graduate programmes conducted by them. Such an exercise was not considered within the scope of this Committee's work.

1,4.3 Though there were some casual references regarding the medium of instruction at post-graduate level, the Committee did not consider this matter in depth and hence no recommendations are made on this issue.

1.4.4 A serious problem the Committee encountered was lack of reliable information on future manpower requirements. Thus, it was not possible to anticipate areas of growth in S&T and to make realistic projections on scientific and technical manpower development, A reliable information system is not available at present. Necessary data are not collected, much less updated, systematised and stored suitably for retrieval as and when necessary.

1.4.5 Another important aspect the Committee could not look into was the trends in the utilisation of post-graduate degree holders in engineering and technology. It would be worthwhile to study the employment pattern of post-graduates in industry, government, education, etc. and also to make inter-comparisons regarding their characteristics, attitudes and performance Information on the relative numbers of engineers/technologists engaged i various functions such as design, operation, production, research, develop-

ment, management, teaching, etc. would be a useful guide to engineering educators and planners. No reliable data were available on this aspect.

The investment of resources in the education and training of post-graduate engineers and technologists is significant in both monetary terms and in the amount of time involved The characteristics and activities of this group warrant careful monitoring, since these highly qualified people provide leadership to the entire scientific community. The Committee feels that the industry, educators, government and others concerned should join hands and together undertake this survey as a matter of urgency.

2.0 EARLIER REVIEWS

2.1 Review by Thacker Committee

2.1.1 In November 1959, on the recommendation of the AICTE, the Government of India appointed a Committee under the Chairmanship of Prof. M. S. Thacker to make a comprehensive study of the state of post-graduate engineering education and research and to recommend the lines along which further development in the field should be undertaken. The Committee submitted its report in August 1961, i.e., about 2 decades ago. Some of the major recommendations are summarised below for ready reference :

(1) In view of the importance of S & T to national progress, a deliberate effort should be made to promote the study of science from as early a stage of education as possible and the cultivation of a scientific temper. As a first step, the science content of secondary school curriculum should be increased.

(2) In order that the science departments of engineering colleges may have broader objectives beyond the purely functional requirements of technological curriculum, the departments should be permitted by universities to conduct master's degree courses in science and also to enrol research scholars for Ph.D degree. At a few selected institutions, the question of conducting B.Sc. course in a limited scale may also be considered by the universities.

(3) At the post-graduate level, training should have two distinct objectives, immediate and long-range. The immediate objective is to train an engineer-specialist in a narrow field, who could readily apply his advanced knowledge of the field to industrial operations, relating to design, construction, manufacturing processes, etc. in a scientific way and also to develop the results of research in their application to industry. The long-range objective is to train engineers with a deeper understanding of the scientific principles underlying engineering who could undertake research and make fundamental contribution to the advancement of technology.

(4) In order to secure these objectives, the structure of post-graduate courses should provide for two distinct courses, one to be designated as post-graduate diploma course of one year duration and another to be designated as master's degree course of two years duration. The essentials of the

courses are : (a) mathematical studies to evolve mathematical models of physical situations ; (b) materials technology to expound the concepts of physical properties of materials ; (c) instrumentation ; (d) rigorous theoretical and experimental analysis of a chosen field of engineering ; and (e) project work that may be either research-oriented or design oriented. Emphasis on these components would vary depending upon whether it is the diploma course or degree course.

(5) Quality and standard should be the watch-word of post-graduate courses. The students should be selected on the basis of their mental ability, maturity, aptitude for advanced work and capacity for concentrated effort.

(6) As a general rule, enrolment for Ph.D. degree should be permitted only after a candidate has obtained master's degree. A minimum of two years research work at an institution should be prescribed as an essential requirement for the award of doctorate degree. In exceptional cases, however, a candidate of high ability may be permitted to enrol directly for doctorate after the first degree, but in those cases, a minimum of three years' work should be prescribed.

(7) In certain special fields of technology, as for instance, advanced electronics, metallurgy, etc. in which a high level of scientific competence is of great value. the post-graduate courses should also be opened to master's degree holders in the appropriate branches of science.

(8) In view of the limited resources available at present, especially in respect of qualified staff, the main bulk of post-graduate courses and research should be concentrated in the initial stages in a limited number of institutions to be chosen specially for the purpose and developed along correct lines. The activity may be extended gradully to other institutions depending upon their resources and abilities. Employment opportunities available to those who have qualified at post-graduate level should also be kept in view in expanding the facilities.

(9) If in addition to institutions selected for post-graduate development on a large scale, any institution is able to establish co-operative relationships with industry or any other technical organisation and is in a position to conduct post-graduate courses on a limited scale, especially

in respect of diploma courses in certain fields of immediate practical value to industry, that should be assisted under the national plan. At the rest of the institutions, the existing conditions should be improved in order to enable them to enter the post-graduate field eventually. In particular, research projects may be sponsored which will create an atmosphere of higher academic work and enthuse the staff.

(10) A radical change in the present staff structure as also in the administrative procedures relating to recruitment, promotions, etc. is necessary. A number of professorships should be created in each major field to represent various branches of specialisation, opportunities of advancement should be created for younger teachers and merit promotions based on the quality of work done by individuals should be essential feature of the organisational set-up of the institutions.

(11) In view of the fact that all advanced studies and research in engineering are essentially team work on the part of scientists, mathematicians, and technologists, special efforts should be made to establishments of physics, chemistry and mathematics in the institutions that should have a strong bias towards engineering and well-qualified staff who could collaborate with the engineering departments.

(12) Adequate provision should be made in all post-graduate institutions for the supporting staff and the services of technicians, mechanics, etc. should be freely available. A well-equipped library generously provided with current and back numbers of journals and periodicals and other types of scientific and technical literature, translation and documentation services is necessary in the institutions.

(13) For a vigorous growth of technology, institutions and industry should come closer and establish co-operative relationships between themselves. The various forms in which such relationships may be promoted may include : industry-sponsored research projects in the institutions: results of research carried out in the institutions to be made freely available to industry: technical and other data to be provided by the industry to help in the projects work of post-graduate students, appointment of the staff of institutions as consultants to industry; research and design office facilities in industry to be made available to post-graduate students; endowment of professorships and scholorships by industry: etc.

(14) The question of conducting co-operative courses in association with industry should be examined by institutions whereby the technical and other facilities available in industry are utilised to the maximum extent possible in the post-graduate development.

(15) Better employment opportunities should be developed for those candidates who have completed post-graduate studies. To this end, industry, technical departments of government and other organisations should give their full support to post-graduate courses. In the recruitment of technical personnel, especially for positions of higher responsiblity relating to research' design and developmental work, post-graduate qualifications should be prescribed as an essential requirement.

(16) Industry and other organisations should sponsor their serving personnel to undergo post-graduate courses and improve their knowledge and competence in their respective fields of work.

(17) All engineering colleges engaged in first degree courses should insist that their future teachers particularly at the senior level should possess post-graduate qualifications in order to be eligible for appointment. They should also send their present teachers who do not possess post-graduate qualifications to recognised centres of post-graduate studies to qualify for master's degree.

(18) Post-graduate students and research scholars should be encouraged to do part-time teaching in the institutions as teaching assistance that would enable them to acquire teaching experience.

(19) The present practice of sending abroad large number of scholars for master's degree or equivalent courses, under the various Foreign Aid Programmes should stop, excepting in those fields in which our facilities have yet to be developed.

(20) Special provision should be made to allow teachers serving in technical institutions to do post-graduate courses on a part-time basis and wherever possible, exemptions from certain parts of the courses should be given to them. Similar provision should also be made to encourage technical personnel working in industry to do diploma course on a part-time basis.

(21) The facilities for post-graduate studies and research developed under the national plan, at an institution should not be restricted to candidates belonging to a particular State or region, but should be open to all candidates, subject to fulfilment of the prescribed academic requirements for admission.

2.1 2 The growth and development of post-graduate education and research in the country since 1961 were to a large extent influenced by the Thacker Committee Report.

2.2 Review by Dr, L.S. Chandrakant

In 1971, nearly 10 years after the Thacker Committee submitted its report, Dr. L S. Chandrakant, the then Educational Adviser (T) to the Government of India, undertook a review of post-graduate programmes and research. Among his main findings - they were highly commented upon by the Post-graduate Board at its 9th meeting held on 16-2-1972 - were the following:

(1) The curricula of post-graduate courses have a heavy padding of theory. In some cases only 20% or less of time is spent on experiments and project work. The curricula of these courses, therefore, need re-organisation. The post-graduate courses can be oriented into two directions; one design-oriented and the other research-oriented. The design oriented courses should be evolved and developed in consultation with industry, so that the products are useful to them. The courses should also provide training in enterpreneur-ship. For this purpose, the industry should co-operate fully in reorienting these courses properly to make them really useful.

(2) The ideal situation would be where the indusrry, the research laboratories and / or the CSIR collaborated intimately in conducting post-graduate courses. A beginning must be made in instituting such programmes.

(3) The duration of post-graduate degree course should be flexible to provide for brilliant students getting their degrees before the normal two years. This can be easily done through credit system of marking, under which a student has to accumulate the required number of credits to qualify for the degree.

(4) The bulk of admissions to post-graduate courses and Ph.D. degree is confined to 10-15 institutions which have developed extensive facilities by

way of faculty, equipment and in some cases industrial collaboration. The question, therefore, is whether post-graduate courses and research effort should be concentrated in a few selected institutions or the majority of less developed institutions should also be allowed to offer facilities for post-graduate courses.

(5) While it is desirable to categorise educational programmes in the major fields of engineering and technology in a number of well-chosen specialities and the institutions should largely conform to these specialities, it may not be desirable to strictly enforce these specialities. Sufficient freedom may be allowed to the institutions to offer courses in new specialities depending upon the felt needs of the industry and the facilities available with them.

(6) The response to the post-graduate diploma courses has not been encouraging. This is partly due to the comparatively longer duration of the course, *viz.* one year. It may not be possible for the industry to spare their personnel for such a long time. In certain cases, necessary collaboration between industry and institutions is also lacking. Special courses for personnel from industry in specialised functional areas as mutually identified by the collaborating industry and the institutions were necessary to upgrade the knowledge and skills of the industry personnel. Such courses should be organised for the industry only. The duration of the courses will narurally vary according to the subject/area and the knowledge of the entrants at the point of entry. The courses, whenever possible, can also be organised on part-time basis Such courses, as far as possible, should be self-supporting.

(7) Technology is changing very fast. It is, therefore, necessary that our post-graduate courses are reviewed periodically and necessary modifications/changes made to suit the requirements of industry. Efforts should also be made to assess the future technological requirements and to institute suitable courses to meet the needs of industry 10 to 15 years hence.

(8) Continuing education for engineers and technologists in industry and educational institutions is essential to keep them abreast of rapid developments taking place in technology and science.

(9) Research is an integral part of post-graduate education in engineering and technology. All post-graduate institutions should be encouraged

to undertake research. Well established institutions should be encouraged to establish schools of research in selected areas. Necessary financial support should be extended to the institutions for undertaking research activity.

2.3 Review of the post-graduate programmes in the IITs and RECs :

2.3.1 In early 1970s, Committees were appointed to review the working of the IITs and RECs. The findings/recommendations of these Committees in respect of post-graduate programme offered by these institutions are of interest.

After considering the review reports of the IITs, the Visitor — President of India — ordered in 1974 that these Institutes should increase their post-graduate admissions to equal the number of their under-graduate admissions at that point of time so that the ratio of post-graduate intake to under-graduate intake is 1 : 1. Close collaboration with industry in opening new courses at post-graduate level, taking more active part in solving problems of industry by greater collaboration with them, development of faculty for other engineering colleges and exchange of faculty with other institutions were also stressed. It was envisaged that during the Fifth Five Year Plan period beginning in 1974, the principal direction of growth in the IITs should be inter-disciplinary research. New areas for such research work were identified in marine engineering, marine biology, rock mechanics, atmospheric studies, ocean bed engineering, food processing, aircraft structures, courses related to defence and development of energy, exploration and development of fuel and other fields of immediate development to meet the economic needs. These courses should be developed on sponsorship basis.

2.3.2 The Review Committee on RECs noted that 13 of the 15 colleges which were primarily set up as under-graduate institutions had started offering post-graduate programmes. Some 29 industry-oriented courses were being offered by 9 RECs, whereas 4 others were offering conventional courses. The Committee observed that utilisation of post-graduate seats in these Colleges was only 50% and only 10 to 30 % of those admitted passed out ! The Committee, therefore, recommended that wherever admission was less than 30% of the approved in-take and the wastage (from the point of view of out-turn) was more than 70%, the post-graduate courses should be discontinued. The Committee also recommended that in order to make these courses successful, it should be insisted that at least 50% of the students

should be sponsored. These Colleges should also establish strong linkages with the IITs to develop their post-graduate courses and research capability.

2.4 Review by the Working Group on Technical Education

2.4.1. In November 1977, on the eve of the launching of the Sixth Five Year Plan, the Government of India in the Ministry of Education set up a Working Group on Technical Education. It made the following recommendations in respect of post-graduate education and research :

(1) The intake capacity for post-graduate courses in the country is generally adequate for the present i.e. till 1983. However, there is a need for re-orientation of some courses. There is need also for courses in certain emerging areas. All these programmes can be accommodated within the existing total intake capacity.

(2) The capability of the technical institutions, particularly at the post-graduate level, for their contribution to rural and community services has been established. However, greater and more effective involvement will be possible by re-orientation of research/project work.

(3) A national agency for evaluation of post-graduate department in engineering and technology should be established.

(4) There should be a common agency for planning, organisation and funding of institutions involved in post-graduate activities covering IITs, university departments and affiliated and non-Government Colleges, etc.

(5) There should be a common agency for planning, organisation and funding of all institutions offering management education to cover Indian Institutes of Management and university departments and affiliated colleges of management education.

2.4.2 At its 24th meeting held on 17th February 1978, the AICTE accepted the above recommendations and resolved as follows :—

"It is essential to optimise the utilisation of available resources and provide impetus to all the Centres engaged in post-graduate

programmes and research. The planning, organisation and prescription of norms for post-graduate and research programmes conducted at universities, Indian Institutes of Technology, Indian Institute of Management and affiliated colleges should be co-ordinated by the Board of Post-graduate Engineering Studies and Research of the AICTE."

2.5 Impact of earlier reviews

From the above, it is clear that the present review is the latest in a long pedigree of official reviews of post-graduate education and research in engineering and technology. All previous reports made many practical recommendations for change. There have, however, been shortcomings in implementing them. Many of the recommendations of the earlier reports are valid still, even after many years since their issue. Many improvements in the present socio-economic situation might have been achieved if more effective action had been taken to implement the recommendations made after the earlier reviews.


सत्यमेव जयते

3.0 PRESENT STATUS OF POST-GRADUATE EDUCATION AND RESEARCH IN ENGINEERING AND TECHNOLOGY

3.1 Growth of post-graduate education and research

Before independence in 1947, there were only six institutions offering facilities for post-graduate education and research in engineering and technology. During the last three decades, particularly after the Second Five Year Plan, the facilities for post-graduate activities were expanded considerably. The table below indicates the position :—

Period	No. of institutions	No. of courses	Intake capacity
Third Plan (1961-66)	29@	114	1750
Fourth Plan (1969-74)	58@	297	2637
Fifth Plan (1974-78)	65@	316	2706
@ excludes IITs and IISc Bangalore			
Present Position 1980	74	346	6111
(including IITs & IISc Bangalore and some unauthorised courses.)			

3.1.1. Intake capacity, actual intake and out-turn

Details of average post-graduate intake capacity, actual intake and out-turn for the three-year period from 1975-76 to 1977-78 in respect of the existing 74 institutions offering post-graduate programmes, are given in the table below. Since the students admitted in a particular year normally pass out two years later, it is clear that the out-turn figures shown in the table do not directly relate to the intake figures.

Institutions	Total Number	Intake Capacity	Actual intake	Out-turn
IITs and IISc Bangalore	6	2000	1817	1117
Universities/University Departments	24	1953	1560	766
Regional Engg. Colleges	13	779	581	282
Non-Government Colleges	14	576	481	245
State Government Colleges	14	632	542	193
Single Faculty Institutions (SPA, NITIE, ISM)	3	171	107	83
Total	74	6111	5088	2686

The detailed course-wise intake and out-turn in respect of each institution are given in Annexure III. The main reasons for the present sudden spurt in intake capacity are : (i) the recent increase in post-graduate intake in the IITs on the basis of Visitor's orders, and (ii) starting of new post-graduate courses by certain institutions without the formel approval of the Post-graduate Board. The list of some of these unapproved post-graduate courses is placed at Annexure IV.

The total post-graduate intake capacity is distributed among the various categories of institutions roughly as follows :

5 IITs and II Sc, Bangalore		32.70 %
24 Universities/University Depts.		32.00 %
13 Regional Engg. Colleges (RECs)		12.83 %
14 Non-Government Institutions		9.40 %
14 State Government Institutions		10.30 %
3 Single Faculty Institutions (SPA, NITIE and ISM)		2.80 %
	Total	100.00 %

3.1.2 Utilisation of available seats

The average utilisation of seats during the three-year period from 1975-76 to 1977-78 is indicated below :

Institutions	Seats utilised at the time of admission	Out-turn (as % of admitted candidates)
IITs and IISc Bangalore	91.00 %	61.50 %
Universities/University Depts.	80.00 %	49.00 %
RECs	74.60 %	40.00 %
Non-Government Colleges	84.00 %	51.00 %
Government Colleges	86.00 %	35.60 %
Single Faculty Institutions	64.70 %	77.50 %

Among the IITs and IISc Bangalore, the IISc stands out with nearly 72.5% of the students admitted to post-graduate degree courses completing the course. The position of IITs in this respect is: Kharagpur 62.65%, Madras 62.1 %, Kanpur 59%, Bombay 53.6% and Delhi 49.66%. The post-graduate diploma courses are mostly for sponsored candidates. Somehow, these diploma courses have not proved to be successful. While the percentage utilization of post-graduate degree seats in a few institutions under the other categories is fairly good, the position in respect of many others is poor.

3.1.3 Doctoral programmes

The intake capacity at doctoral level cannot be easily quantified since these programmes are highly individual-oriented. It appears that about 63 institutions are offering programmes leading to doctorate degree in engineering and technology. About 1800 candidates are today doing doctoral research in engineering and technology all over India. On an average about 500 candidates register for doctorate and about 350 candidates qualify for doctorate degree every year.

3.1.4 Statistics of post-graduates produced

As on today, India produces about 350 doctorates, 2700 MEs/MTechs and 16500 graduate engineers (in the ratio of about 1:8:47) annually, whereas annual intake provisions are 500, 6000 and 26000 (1:12;52) respectively.

Enrolments for doctorate, master's degree programmes and under-graduate programmes in engineering and technology in the 290 engineering institutions in the United States for the fall of 1978 were 12321, 26060 and 95805 (1:2:8) respectively.

Numbers of post-graduates and doctorates in engineering so far produced by the various institutions in India are in Annexure V.

3.2 Structure of post-graduate programmes and course requirements

3.2.1 By and large, almost all institutions (with some exceptions) follow the structure recommended by the Thacker Committee for post-graduate programmes (diploma, degree and doctorate) with some minor variations. Out of the 2 years of post-graduate degree programmes,approximately 50% of the time is devoted to course work and the rest to research/design/project work. The Bombay University has not prescribed any course work for post-graduate degree programmes in pharmacy etc.

3.2.2 The one-year post-graduate diploma courses are related to the particular needs of industry and consist of about 80% course work and 20% project work. These courses have not generally proved to be popular.

3.2.3 In general, the duration prescribed for doctoral work is 2 to 5 years. It is based essentially on research, though some institutions have included course work in partial fulfilment of the requirements for a doctorate. In respect of those with a master's degree, the IIT Kanpur has prescribed 48 credit units for course work and 96 credit units for research. For those who go for doctorate immediately after BTech, the Institute has prescribed 144 credit units for course work and 96 credit units for research.

Most universities do not prescribe any course work for doctorate. Wherever course work is prescribed, the candidates are required to pass a written examination before starting the thesis work.

3.3 Entry qualifications

3.3.1 In 1974, the Government of India laid down that only those who get a minimum of at least 60% marks (55% for backward classes) in their BE/BTech would be eligible for the scholarship of Rs. 400/- per month

for the post-graduate degree programmes. In view of this, the IITs and many other institutions have prescribed this as the minimum admission requirement for post-graduate degree programmes. While the IITs make admission through an entrance examination, the IISc has an elaborate system of entrance examination together with assessment of the past academic records of the candidates.

3.3.2 A number of other institutions have prescribed a mere pass in engineering degree examination as the requirement for admission to post-graduate degree pregrammes. Some institutions admit even AMIE certificate holders (with certain conditions) to post-graduate degree programmes in engineering and technology. It is presumed that among the candidates admitted only those who have got at least 60% marks in their BE/BTech are given post-graduate scholarships of Rs. 400/- per month.

3.3.3 The UDCT Bombay prescribes a mere BSc second class for admission for its M.Sc (Tech) course. The Birla Institute of Technology and Science (BITS) at Pilani has prescribed MSc (Hons.) as alternative qualification for admission leading to master's degree in engineering. Master's degree holders in geography, economics, sociology or social work with 60% marks are eligible for admission to the master's degree programme in town planning in many institutions. The School of Planning and Architecture (SPA) at Delhi has prescribed a degree in architecture or town planning with 60% marks or master's degree in geography with 60% marks as admission requirements for post-graduate degree programme in town and country planning. BSc students with mathematics and with five years experience are admitted to the post-graduate diploma programme in the VJTI at Bombay, if these candidates are sponsored by their employers.

3.3.4 All the 63 institutions offering doctoral programmes have prescribed master's degree in engineering / technology as the minimum admission requirements for doctoral programme. No specific limits in terms of marks or class have been laid down. However, the premier institutions normally admit only first class master's degree holders for doctoral programmes. In exceptional and very deserving cases. the IITs and some institutions like the UDCT Bombay allow distinguished bachelor's degree holders to go directly for doctorate.

3.4 R & D activities

3.4.1 Almost all post-graduate institutions are engaged in R & D activities. During the *one year* 1977-78, the IITs and IISc Bangalore handled 666 sponsored research projects. Doctoral research projects in progress were 1400, while the total number of post-graduate degree and diploma research

projects was 1100. The position in regard to other categories of institutions for the *five-year period* ending 1977-78, is as under :—

	Sponsored research projects	Ph.D. projects	M.Tech. projects
14 Universities/University Departments	450	280	1497
13 RECs	148	189	1158
12 Non-Government Colleges	114	107	528
13 Government Colleges	39	65	612
3 Single Faculty Institutions	61	87	101
Total	812	728	3896

Institution-wise details of R & D activities are given in annexure VI.

3.4.2 The number of sponsored schemes handled by the 5 IITs and the IISc Bangalore is large when compared with that handled by the other post-graduate institutions. Among the non-IIT/IISc institutions, the record of performance of some is very good, while others have not been able to make any impact in the area of sponsored research.

3.4.3 Annexure VII gives the particulars of doctoral research projects in progress at 63 (out of 74) post-graduate institutions during 1977-78. In the IITs about 31 to 38% of the faculty time is reported to be devoted for research training. In the IISc Bangalore, where 40% of the scholars are aspirants for doctorates, faculty time spent on research training is about 50%. In other institutions, except in one or two University Departments, the faculty time spent on research training is insignificant. The IITs have estimated that 60% of their budget is spent on research activities. In the year 1978, the IIT Bombay had the largest number of research scholars (318), followed by Delhi (257) and others around 150 each.

3.4.4 About 70% of the PhDs in engineering/technology are produced by the 5 IITs and IISc Bangalore, the remaining 30% coming out of the other 57 institutions offering doctoral programmes. About 66% of all research scholars for doctorate are placed in the IITs/IISc. The shares of University Departments, RECs, State Government Colleges, Non-Government Colleges and Single Faculty Institutions being 15%, 8%, 3%, 5% and 3% respectively. Annexure VIII shows that in 1976-77, 37 universities/insti-

tutions awarded 329 doctorates in engineering and technology (data published by the Association of Indian Universities). Of these 329 doctorates, the 5 IITs and the IISc Bangalore produced 223 and the remaining 31 universities only 106 (i.e. about 3 per university).

3.5 Industrial liaison and consultancy

3.5.1 Information on consultancy projects undertaken by the various categories of institutions is at Annexure IX. While all the institutions claim to be engaged in consultancy work, only the 5 IITs and IISc Bangalore have made a real impact in this area. These 6 Institutes had on hand 831 consultancy projects in the year 1978. These Institutes have set up separate centres to co-ordinate and process industrial research and consultancy projects and they are doing very well. The IIT Madras took 57 patents in 1978 alone.

While it is expected of IITs and IISc to do well in industrial liaison and consultancy, the performance of some of the smaller institutions in this area has also been quite good.

3.5.2. Almost all post-graduate institutions except a few have been undertaking testing and calibration work. Many of them are approved by the DGS & D for testifying items as per ISI standards. The IITs have been advised not to take up routine testing work.

3.6 Publications

During the *one year* 1977-78, the 5 IITs and IISc Bangalore published/ presented about 3700 papers (i.e. about 616 papers per Institute) in various journals/conferences and also produced about 100 books/monographs. The performance of other categories of institutions during the *5-year* period ending 1977-78 is given below:

24 Universities/University Departments	2000 papers and a few books. (i.e. 17 papers per university per year.
13 RECs	2200 papers and 8 books (i.e. 34 papers per college per year)
14 Non-Government Colleges	1300 papers and 20 books (i.e 19 papers per college per year

14 Government Colleges	646 papers (i.e. 9 papers per college per year)

Among the Single Faculty Institutions, the ISM Dhanbad published 75 papers and 6 books in 1977-78 alone.

3.7 Continuing education programmes

3.7.1. The detailed position in this respect is placed at Annexure X. During the year 1977-78, the IITs and IISc Bangalore organised about 300 symposia/short-term-courses/seminars etc. They have also actively participated in the other Quality Improvement Programmes (QIP).

3.7.2 While a few non-IIT, IISc institutions have also done fairly well in organising continuing education programmes, the contribution of many others is insignificant.

3.7.3 The IITs and IISc Bangalore have brought about many educational improvements by developing new curricula, offering new electives, introducing new experiments and innovations etc.

3.8 The general profile

3.8.1 The general profile that emerges is clear. The performance of about half-a-dozen institutions in the area of post-graduate education and research has been quite good mainly due to deliberate efforts and liberal investments in promoting them.

3.8.2 In spite of the considerably lower inputs, about 20 other institutions have done creditably well. The progress and performance of the remaining 50 or so institutions have been inhibited by various factors, even though some of them have succeeded in developing some areas and disciplines well.

3.8.3. The survey of physical facilities such as faculty, accommodation/space, equipment and library has shown that the condition of many of these institutions is deplorable. The facilities available in the 5 IITs and the IISc Bangalore, although not comparable with those in good institutions abroad can be said to be very good. The condition of the RECs and a few other institutions is fairly satisfactory, though there is need for further improvement. In almost all the other institutions, the provision of physical facilities is totally inadequate. The poor norms for giving assistance and differences in the patterns of funding have been responsible for this state of affairs.

3.8.4. In this critical review of the present status of post-graduate education and research, it should go on record that in spite of the many limitations, defects and inadequacies mentioned above, the existing system of post-graduate education and research in India has made valuable contributions to the growth and development of the country in various spheres covering the entire spectrum from earth sciences to space research.


सत्यमेव जयते

4.0 MAJOR ISSUES, PROBLEMS AND SUGGESTIONS

4.1 The need for post-graduate education and research

4.1.1 The strength and prosperity of a nation very much depend upon its technological capacity and capabilities. This is explicit in the Science Policy Resolution of the Government of India (1958), which expressed the intention of the Government in general terms to foster science and technology for the development of the country. Though India has made significant strides in diverse fields since independence, she has a very low per-capita income and continues to be one of the poor countries in the world.

4.1.2 It is often quoted that India is among the first 10 industrialised nations of the world, that she has the second or the third largest stock of scientific and technical manpower in the world etc. The fact remains that the science and technology content in the Indian society(as indicated by the national investment in this sector, number of technically qualified personnel, facilites for science and technology education, size of technical services etc.) as well as the extent of her involvement in R & D in particular, are incredibly low. According to the Research and Development Statistics 1976-77, published by the Department of Science and Technology, Government of India, the number of scientific and technical personnel in India per 1000 of population is only 3.8, whereas it is 12 in the United States, 19 in the Federal Republic of Germany (FRG), 82 in the USSR and 185 in Japan. Scientists and engineers engaged in R & D in India per 1000 population is only 0.09, this figure being 2.68, 2.97, 3.72 and 4.98 in the United States, FRG, USSR and Poland respectively.

4.1.3 Vigorous measures are being taken for the creation of a sound scientific and technological base in the country by mobilising adequate resources. This is evident from the fact that expenditure on R & D has increased from a paltry sum of Rs. one crore in 1948-49 to about Rs. 450 crores in 1976-77. The expenditure on R & D, which was 0.23% of GNP in 1958-59 has risen to 0.6% of GNP in 1976-77. The expenditure on R & D as a percentage of GNP was 2.1 in UK (1972), 2.3 in the FRG (1974), 2.3 in the United States (1975), 2.5 in Japan (1975) and 2.7 in Poland (1975). Exclusive of defence R & D, the draft Sixth Plan of India had envisaged an expenditure of Rs. 2500 crores on S & T, as compared to Rs. 1070 crores in the four years of the Fifth Plan (1974-78).

4.1.4 In this context, it may be pointed out that as the world is structured today 95% of all research is done in the developed countries. Six countries - the United States, U.K., France, Japan, USSR and FRG - account

for nearly 85% of all R & D expenditure and 70% of R & D manpower resources. In absolute terms, the United States supports more than 50% of the R & D performed in the world. About 90% of the global technology trade takes place within the industrial world. Of this more than half is within the transnational corporations. Both General Motors and IBM spend more on R & D than countries like India, Spain and Republic of Korea combined.

4.1.5 It is evident that the capacity for generating technology within the country has to be strengthened considerably and vigorous steps taken for the continual improvement of that capacity. The quantity and quality of R & D in a society depends upon the quantity and quality of scientific and technical personnel engaged in it. Since the total stock of India's S & T manpower is quite small relative to her population and corresponding national needs, this stock will have to grow at a faster rate—particularly in quality—during the coming decades. If the above indicated statistics and relationships have any significance, then our national investment in scientific and technical education and research must increase many fold to meet the growing needs of our social system.

4.2 Attitude towards post-graduate education and research

4.2.1 Science and Technology are developing too fast and so do their potential applications both in extent and diversity. The diversification of scientific and technical knowledge in increasing immeasurably and fields of specialisation now number is the order of a thousand. It is obvious that if properly trained, engineers with post-graduate qualifications can function more fully than engineers with a bachelor's degree. It seems desirable to recognise publicly and to publicise more widely that post-graduate studies are a normal part of engineering education. The unreasonably restrictive conception that a bachelor's degree is sufficient preparation for most engineering work should not be perpetuated. It is not at all a happy situation that today of the total S & T manpower employed in the public sector R & D organisations in the country, only 2% are doctorates in engineering and 12% master's degree holders. In the private sector, these figures are 1% and 9% respectively.

4.2.2 All these concerned with and involved in industry should review their activities to ensure that they perceive and present post-graduate engineering education and post-graduate engineers as matters of vital national concern in their own right. A sustained national programme should be launched to stimulate more widespread understanding among employers of the nature and importance of the engineering dimension and of the potential benefits to them from employing post-graduate engineers in a

wide range of activities. Employing organisations should review their salary and career structures for engineers to ensure that they adequately reflect a value for post-graduate engineers' contributions.

4.2.3 Post-graduate degree in engineering and technology has been prescribed as the minimum qualification for appointment as Lecturers in engineering colleges. It should be made mandatory to prescribe post-graduate degree as the minimum qualification for recruitment to many positions in the engineering profession in industry, R & D organisations, Electricity Boards, Public Works Departments, P & T, Railways, etc. It is time to do away with the present policy and practice of recruiting graduate engineers at the lowest levels (single point entry) to many services including Railways, BARC etc. As an incentive and mark of recognition, it should be mandatory to give not less than two extra increments whenever post-graduate degree holders are recruited at the lowest level where the minimum qualification prescribed is a bachelor's degree in engineering. A suitable number of advance increments should also be given to doctorate degree holders. This is invariably done in advanced countries.

4.3 Objectives of post-graduate education, rural technology, extension service

4.3.1 In the light of the numerous suggestions on this theme the basic objectives of post-graduate engineering education in a developing country like India can be stated as follows :

(1) development of specialist knowledge in specified fields of national relevance ;

(2) strengthening of the ability of innovation, adaptation and optimisation in the matter of design and development of engineering systems ;

(3) training in research methodology and real-life problem solving ;

(4) strengthening the perception of the technological resources and needs of the country and the development of competence for technological assessment for a given application ;

(5) training in competent handling of problems of technology transfer, whether from a research laboratory to a manufacturing or utility-industry or from one social framework to another ; and

(6) development of strong interaction with industry through sharing of facilities and expertise and through solution of industrial problems.

Although all the above six objectives could equally well apply to post-graduate education in a developed country the emphasis on the last three has to be much more in a developing country like India which does not have a well-built tradition of technology generation and growth.

4.3.2 Although the problems of rural relevance are intimately connected with the lives of three-quarter of the world's population, they have been conventionally viewed as being outside the mainstream of S&T. These problems should be the legitimate concerns of engineering and science. The set of traditional technologies which the bulk of humanity had evolved over the centuries, and depended upon for its survival, has become increasingly inadequate in the context rising expectations, changed circumstances, increasing populations and depleting resources. At the same time, the technologies of the advanced countries seem to have become too demanding in their use of capital, energy, and non-renewable resources to become available to all sections of humanity-they appear to be inherently exclusive. This sitution in which the traditional is invariably inadquate and the modern is largely inaccessible can only be overcome by the proliferation of alternative solutions through massive inputs of S & T.

The problems of rural areas appear quite mundane, but they are certainly not trivial. They demand the same vigour, sophistication, subtlety and creativity as is generally associated with the technologies of the industrialised countries. From this point of view, the labelling of rural technologies as 'low' or 'primitive' represents a confusion over criteria. It has already been demonstrated that problems of rural relevance can be as scientifically challenging, intellectually stimulating and professionally satisfying as other concerns of engineering science. Rural development centres are functioning in a few technological institutions. This acrivity should be encouraged and expanded in a big way.

4.3.3 Higher technological institutions would do well to accept public service as one of their functions and extension service as a third dimension in addition to training and research. Extension service is to get into the real world, to learn the live problems, to get the feed back, to make the public aware of the institution and its capabilities, to serve the society and to build linkages with other developmental agencies. Extension service may cover setting up of service centres, field services and cousultancy services both for large and small scale sectors and for rural development. It may also cover setting up research parks within the campus or running pilot plants for the industry.

Extension service in education system helps to build a two way communication, to sell its products and to help the mobility of personnel in teaching, research, industry and field activities. With the present thrust on rural development and the need for technical education system to involve itself more in these activities, it can be stated that the infrastructure available is of such quality that, given the orientation, it would not be difficult for the system as such to involve itself more effectively in rural and community services. The post-graduate institutions can contribute to a great extent in the adoption of necessary technology for rural and community purposes by integrating in their programmes project activities suited to these needs.

4.4 Brain-drain, drop-outs, mode of admission, scholarships

4.4.1 It has been stated time and again that only students of the very best quality should be admitted to post-graduate programmes. Unfortunately, the failure on this front has been almost total and consequently the standards in most institutions have come down considerably. This is a serious matter, which will have far-reaching consequences on the future technological competence of this country.

4.4.2 The various views expressed to the Committee showed that for a variety of reasons which include redundant and outdated courses, inadequate facilities. lack of motivation, long duration of courses, lack of recognition and incentives, incompetent administration of the programmes, lack of employment opportunities, etc., it has not been possible to attract many bright young people for post-graduate education, For the same and similar reasons, even those students who join these programmes leave sooner or later. The drop-out rate has been from 20 % to 100 %, resulting in an enormous drain on resources.

According to certain studies, about 25% of the top engineering graduates produced by some of our best institutions leave the country every year. Apart from the physical and social costs of brain drain that are usually commuted, an important dimension of the loss is the 'reverse transfer of technology' through the migration of such high quality manpower to the developed countries. The loss of the potential for innovative technology embodied in this sort of brain drain is to be taken as a defeat of the very purpose of the high quality technological education.

4.4.3 Strong and firm measures should be taken immediately to remedy the situation. Only bright and motivated people should be admitted to post-graduate programmes. The following measures are suggested :-

(1) All existing post-graduate programmes which have not turned out any qualified candidates for three years consecutively and those programmes

which were not able to admit five candidates or 50% of the approved intake (whichever is less) for three years consecutively in any institution, including the higher technological institutes, should be wound up. However, in exceptional cases where the demand is for a smaller number, this rule may not apply.

(2) Physical facilities in institutions conducting post-graduate programmes should be considerably improved by giving them support on the basis of the revised norms suggested in this report (4.12).

(3) It is vitally important to ensure that only meritorious and motivated students are admitted to Post-graduate programmes. To achieve this objective, an aptitude test for graduates in engineering and technology—to be called GATE (Graduate Aptitude Test in Engineering)—should be held at the national level, two or three times in a year at widely dispersed centres. The test shall be designed and administered by an appropriate national agency identified for the purpose. On the basis of this test, a list of those found eligible for admission to Post-graduate courses in engineering and technology should be published and made available to all the concerned institutions. In making admissions to these courses, the institution will take into account the score obtained by a candidate in the GATE together with the marks/grades credit point average and any distinctions obtained by him in his preivious academic career.

Those sponsored by industry or other institutions will also be required to appear in the GATE and should find a place in the eligibility list to qualify for admission into a post-graduate programme. Apart from graduates in engineering, those with AMIE (plus diploma in engineering or certificate in laboratory training) or equivalent qualification should be eligible for admission to the GATE. Industry, Electricity Boards, PWDs, public and private sector undertakings, Railways, Posts and Telegraphs etc., should be encouraged - directly and indirectly - to sponsor candidates for Post-graduate Education in their respective areas of interest. Residential requirements may be waived in the case of candidates sponsored by industry.

(4) This procedure for admission to the Post-graduate programmes will obviate the need for a candidate to appear in a multitude of entrance tests conducted by several institutions, will impart an all-India flavour to the pattern of admission into post-graduate programmes and will help to establish national standards with regard to the quality of those who are eventually admitted to these courses. In the conduct of the GATE, suitable concessions/considerations should be shown to SC/ST candidates as is done in the Joint Entrance Examination (JEE) for admission to IITs.

(5) Admission to Post-graduate courses should be on an All-India basis and should not be restricted to local candidates. Wherever necessary and possible, admission to any one course may be increased to 50% more than the approved intake. However, in all such cases the overall Post graduate intake should be within the total ceiling prescribed for the institution.

(6) Post-graduate scholorships for ME/MTech should be enhanced from the present value of Rs. 400/- per month to Rs. 600/- per month. All candidates admitted through the GATE would be eligible to get the scholarship. However, sponsored candidates who get their salary from the sponsoring agency would get only 75% of the value of the scholarship.

(7) Fellowships for doctoral aspirants should be raised from the present value of Rs. 500/- to: first year Rs. 700/- per month, second year Rs. 800/- per month and third year Rs. 900/- per month. The fellowship value should be enhanced by Rs. 50/- after submission of the thesis and should be continued for 3 more months or till the *viva* is over, whichever is earlier. There should be uniformity in the fellowships awarded by various agencies.

(8) Values of all scholarships/fellowships should be reviewed once in every three years.

4.5 Courses and their structure

4.5.1 The structure and course requirements of the existing programmes have already been explained in section 3.2. The one-year post-graduate diploma course which was recommended by the Thacker Committee primarily to meet the requirements of industry has not been found to be popular and successful in most of the institutions. Even the industry oriented post-graduate degree programmes which were introduced in some of the institutions with support from UNESCO have not been effective. Many feel that the duration of two-years for an ME/MTech programme is too long and that this is one of the main reasons for its unpopularity. The existing courses and their structure came in for a lot of criticism from all sections. The curricula and syllabi of most of the post-graduate courses have not been revised for years.

4.5.2 There was near unanimity that the one-year post-graduate diploma course need not be offered as a regular programme unless such a course is specifically asked for and paid fully by the interested agencies.

As far as post-graduate degree is concerned there was a pervasive view that the 2-year programme is too long and could be shortened without sacrificing quality or content. The general feeling was that all ME/MTech programmes should be of three semesters duration consisting of two semeters rigorous course work including core and elective subjects and one semester of dissertation work.

4.5.3 Broadly speaking, the ME/MTech curriculum should have a course content of :-

(1) 30 to 50% core area subjects

(2) 50 to 70% optional area subjects and

(3) Dissertation on live problems or on topics in emerging areas.

The course work may have a total credit units of 35 to 40 and the dissertation 20 to 25 credit units. Most of the course work should be at a level beyond the normal bachelor's degree and no credit should be given for make-up courses or for broadening in undergradute courses outside the major field.

The dissertation should offer an opportunity for the candidate to engage in a creative and self-learning experience. It should be either design oriented or project oriented. The theme for the dissertation should be decided within four weeks after admission, so that the thinking on and preparation for the dissertation would start right at the beginning. The topic of the dissertation should as far as possible be trans- disciplinary in nature. In any case, there should be two guides—one being preferably from industry—to evaluate the dissertation. The concept of joint guides can have a very positive impact on the post-graduate education system and hence should be encouraged. Unless the dissertation work is properly supervised and guided, it may turn out to be neither good research nor good engineering.

4.5.4 The ME/MTech programmes should be offered in suitable modules with credit system. The candidate may be allowed to complete the degree in a span of two to three years (mainly for sponsored candidates). The scholarships will, however, be given only for the prescribed duration of three semesters. This restructuring of ME/MTech programmes should be undertaken as a matter of urgency in close collaboration with people from industry, R & D organisations, and others concerned. It is also necessary to set up Post-graduate Curriculum Development Centres to revise, redesign and up-date the curricula of post-graduate programmes on a continuing basis as per the above suggestions.

While restructuring the ME/MTech programmes, it should be clearly remembered that they are to prepare persons of high quality and calibre for all engineering functions including design, development, technology assessment and transfer, management, research etc. An individual department/institution may wish to emphasise one or more of these functions depending upon the kinds of faculty, students and facilities it has.

All ME/MTech students should be required to work for the institution/ department at least 3 hours per week in the form of assisting in tutorial work, laboratory development or under-graduate project supervision.

4.5.5 Doctoral work should certainly be regarded as preparation for the highest levels of creative leadership in all areas of engineering practice including teaching and research, and efforts should be made to expand the facilities and opportunities for increasing the numbers of engineers who wish to take the doctoral degree.

The minimum duration for doctorate after ME/MTech should be two years of full-time study and research. However, some people felt that the existing system of allowing BEs/BTechs to go directly for doctoral work in exceptional and deserving cases should continue, in which case, the minimum duration for doctorate should be three years. In either case, fellowship would not be paid for more than four years.

4.5.6 All aspirants for doctorate should invariably go through some advanced courses relevant to the area of research. "Candidate based" Doctoral Committees should assess the candidate's competence and identify his deficiencies. The candidate should be required to pass a written examination in the course subjects and in the subject matter of his thesis. The course work for doctoral programmes should be revised and updated every year. All doctoral aspirants should be required to put in 4 to 6 hours of work per week in assisting the academic programmes of the department/ institutio .

A critical aspect of the doctoral requirements has to be the thesis which should provide an important creative experience to the students. Indeed, the successful completion of this creative experience makes the doctoral programme a valuable career preparation; the creativity thus encouraged can be turned to any aspect of engineering profession as well as research itself. Innovation, social/practical relevance and originality should be the hall-marks of doctoral work.

The policies for recognising supervisors for guiding doctoral candidates should be made uniform. There are wide disparities at present.

4.6 Emerging areas

It is well known that many of the existing post-graduate degree programmes are out-dated and stereotyped. They have also proliferated out of all proportions. The same courses are being offered by too many institutions.

Almost all sections of the people whom the Committee talked to emphasised the need to wind up many of these courses in the manner they are offered now and to introduce new courses in the emerging areas some of which are mentioned in the Annexure XI. Wherever possible, attempts may be made to redesign the existing courses to include relevant and emerging areas. Narrow and futile definitions of disciplines are dangerous. Care should be taken to see that interdisciplinary areas do not become independent areas. Interdisciplinarity has become a highly complex process involving a large number of specialists from essentially different disciplines. Gone are the days when it was possible to be simply a civil engineer or a mechanical engineer !

4.7 Criteria and policy for starting new courses, impact of post-graduate programmes on under-graduate education

4.7.1 Among the many suggestions on this theme were : all institutions should be allowed to start post-graduate courses; neighbouring institutions should not be allowed to offer the same courses; post-graduate courses should be concentated at a few selected places; a number of reputed institutions should be identified for development as Centres of Advanced Technology and as nuclei of regional technological development; no new post-graduate courses should be introduced without strengthening and consolidating the old ones; lecture-based (as distinct from laboratory-based) post-graduate courses should be offered in small colleges; concentrating post-graduate courses only in a few centres would impede the growth of other centres of education and training etc. etc.

4.7.2 In view of the limited resources available and also the need to maintain high standards, sanctioning of new post-graduate courses has to be done with utmost care. The main criteria should be :

(1) The courses should be need-based and of national relevance. They must be in emerging areas.

(2) For a few years to come, post-graduate courses should be introduced only in established institutions which have already proved their compe-

tence, which have developed an industry culture, and which have cultivate trans-disciplinary and trans-organisational approach to research.

(3) Under no circumstances should further proliferation of exist programmes in conventional or irrelevant areas be permitted. Emp building within institutions and between institutions should be discouragec

(4) As far as possible, courses should be sanctioned only on all-In basis and not on local considerations.

(5) Neighbouring institutions should be encouraged not only conduct post-graduate Programmes jointly, but also to share jointly facilit such as faculty, library, equipment etc.

In his report submitted to British Parliament in January 1980, Montague Finniston has recommended among others that "regional consorti arrangements should be set up to link several academic departments in a reg in order that between them they can sustain a range of MEng. courses their students".

4.7.3 Post-graduate activity is a logical sequel to a well-develop system of under-graduate courses in an institution. It has certainly a posit impact on the standards of under-graduate courses. Post-graduate cour should not be developed at the cost of under-graduate courses. The effects the former should percolate to and strengthen the latter. Therefore, on a lor range basis, all institutions should receive support and encouragement enter the post-graduate field depending upon their ability and interest. institutions where post-graduate work has not yet been initiated, resea projects in selected areas may be sponsored in order to create an atmosph of higher academic work and to enthuse the staff. Simultaneously, inf structural facilities in these institutions should be improved.

4.8 Faculty

4.8.1 Next to the student body, the faculty is the most import factor in assuring the success of any engineering education programr Technical competence, scientific understanding, creative ability and human tic wisdom are required - particularly for teachers at post-graduate level. quote from Grinter Report on Evaluation of Engineering Education in t United States: "Distinguished faculties are far more important to t advancement of engineering education than details of curricula or magni cence of facilities".

4.8.2 In the course of the Committee's work, teachers came in sharp criticism almost from all sections - including teachers themselv

Instances of indifference and incompetence, incorrect attitudes and inadequate aptitudes etc. were profusely cited. It was also pointed out that a tendency to inbreeding even in our national institutions has brought down the calibre of teachers and the level of post-graduate education.

Mobility and exchange of faculty between academic institutions, R & D organisations and industrial establishments should be encouraged to prevent inbreeding. To facilitate such free mobility and exchange of personnel, the existing rules and regulations regarding inter-organisational deputation etc. should be modified and liberalised. Industrial experience should be prescribed as an essential qualification for teaching positions at post-graduate level. The UGC has recently prescribed industrial training as compulsory qualification for teaching positions in engineering colleges in all universities.

4.8.3 Possession of a doctorate degree or equivalent qualification representing an advanced level of intellectual attainment and creative endeavour should be made a pre-requisite for post-graduate teaching. Continued up-grading of post-graduate faculty should be ensured through sabbatical leave, summer institutes, refresher courses, creative research, consulting and industrial experiences etc. Continuing studies are as important for engineering faculty as for engineers in industry and eleswhere. This should be made compulsory/mandatory. Educational institutions, engineering profession, industry and government should jointly develop a variety of programmes designed to enhance the development of engineering faculty members as practising engineers through the effective use of study leave, summer training, consulting and research opportunities.

4.8.4 The recruitment to teaching positions at all levels should be made only on an all-India basis after close scrutiny of the competence and qualifications of the candidates *vis-a-vis* the prescribed job requirements. TA/DA should be given to all those who are called for interview. Appropriate screening techniques and recruitment procedures should be adopted to ensure selection of persons of the highest calibre.

4.8.5 A rigorous 'staff appraisal scheme' (this is different from confidential reports) to assess the teacher annually in the area of teaching, laboratory work, research and publications should be introduced in every post-graduate institution. Staff appraisal records should be looked into at every stage of promotion. Teachers should also be asked to evaluate themselves through self-assesment schemes. Appropriate merit promotion schemes should be introduced in engineering colleges/institutions. It is understood that the UGC has recently prepared a comprehensive merit promotion scheme.

4.8.6 It is necessary to provide for student representation in academic committees of departments/institutions at post-graduate level. Establishment of Student Affairs Committee (or the like) consisting primarily of students/ research scholars, to discuss academic issues should be encouraged.

4.9 Maintenance of eqipment

4.9.1 In almost all post-graduate institutions, including institutions of national importance, many items of costly and sophisticated equipment are neither maintained nor utilised properly. The position is the same in many of the R&D organisations. The main reason is that the staff are not trained to handle sophisticated equipment. This is also part of the poor maintenance culture of the country.

4.9.2 It is necessary to introduce some sort of standardisation in the procurement of equipment. The present practice of getting too many types of the same item of equipment from many different countries should be discouraged.

4.9.3 A specialist cadre of maintenance technicians/engineers should be built up atleast on a regional basis. Experience and competence should be the criteria for recruitment to this cadre. People recruited to this cadre should, wherever necessary, be sent abroad for training. They should also be given proper status and adequate scales of pay comparable to those of other specialists.

4.9.4 Meanwhile, a small team of competent instrument mechanics/ experts should be asked to examine the sophisticated equipment now lying idle in the various post-graduate institutions with a view to set them right. If it is necessary to import spares, this should be done as a matter of urgency.

4.9.5 It is also necessary to create in some of our institutions an infra-structure for training in the instrumentation area with particular reference to repairs and maintenance of sophisticated equipment. Institutions like the IITs and RECs should ensure that they are capable of maintaining and repairing their own equipment and those of others in that region. In this endeavour, they should co-operate with the CSIO and also with the Regional Sophisticated Instruments Centres (RSICs) set up by the DST and the University Service and Instrumentation Centres (VSICs) established by the UGC.

4.9.6 Instrumentation is becoming more and more complicated and sophisticated incorporating latest technologies. In recent years the development of research has increasingly involved synergistic action, necessitated

mainly by the fact that huge and costly facilities and equipment are indispensable to carry out research in many new areas such as oceanography, information processing, remote sensing, natural resources surveying etc. In view of the limited resources and to facilitate proper maintenance, it is advisable to create centralised facilities at a few Centres of Excellence identified for advanced research in these emerging areas. A beginning in this regard has already been made in the IITs.

4.10 Research

4.10.1 It is clear that there is a growing R & D function in engineering education especially at post-graduate level. There should be the fullest possible integration of research with the edcational purpose. Post-graduate programmes can survive only on a strong R & D base. Unfortunately, research in post-graduate institutions is not doing as well as it ought to: 'The precise extent to which research workers are wasting energy in repeating experiments that have already been made is difficult to estimate..... It is indeed more than possible that half the energy expended in experimental research is dissipated in useless repetition'. This excerpt from the editorial of Nature dated 15-12-1928 (i.e. 52 years ago), holds good even today as far as research in the post-graduate institutions in India is concerned. A good amount of research work going on in the country is without review and accountability.

4.10.2 Another important aspect is that unfortunately—for historical reasons—science and technology has so far developed in India under Western perspectives. Most of our institutions including the higher technological institutes, carry out research on borrowed ideas and on problems which are totally out of context. Fashion-oriented research gets quick recognition. It was reported that the foreign examiners did not understand and appreciate theses on Indian problems. The Committee would like to emphasise that the main aim of research should not be to publish papers, or to act as cheap scientific labour for just monitoring data for global projects of the affluent countries, but to produce something useful and relevant to this country. On this issue Finniston Committee's recommendation to the British Government is : 'Academic research in engineering departments should emphasise work done in a context of economic purpose'.

4.10.3 There is urgent need to take deliberate action to prevent enormous wastage of resources on repetitive and irrelevant research projects. Some institutions have done well in undertaking sponsored research projects and consultancy projects. This culture should be developed without detriment, of course, to the academic and training duties/commitment of the institution.

4.10.4 The institutions should be allowed to charge sponsored research projects. Consultancy should be encouraged and regulated on the basis of pre-determined norms. While the emphais should be on institutional consultancy, individual consultancy should also be allowed especially when institutional facilities are not utilised. However, it should be ensured that individual consultancy facilities are not misued. The money earned from sponsored and consultancy projects should be utilised for developing the research capability of the institutions. Industrial consultancy should not be confused with routine testing and analysis, which should be discouraged.

4,10.5 Multidisciplinary, trans-disciplinary and transorganisational research with emphasis on design and development should be encouraged at master's, doctoral post-doctoral levels. The projects should have academic and industrial elements. They should aim at developing instruments, evolving new technologies and solving problems of the industry and R & D organisations. The post-graduate projects should as far as possible be sponsored and/or techno-economic oriented.

4.10.6 There should be more and more of Indian case studies and these should be published. Problems of industry should be documented and distributed to post-graduate institutions on a continuing basis. It is suggested that a national level R & D News Letter (like the Employment News) should be published regularly giving information on research projects at master's, doctoral and post-doctoral levels for the benefit of post-graduate institutions, R & D organisations and industry. It may be a good idea to organise an All India Conference on post-graduate projects and to document these projects area/discipline-wise atleast once in two years.

The culture of post-doctoral research needs to be considerably developed and strengthened.

4.11 Sponsored research staff :

4.11.1 A few post-graduate institutions undertake a large number of sponsored research projects which are sponsored by the Government departments, public and private sector undertakings etc. Additional staff of good quality and calibre are required to be recruited by these institutions to do this work. Since these staff are recruited temporarily for sponsored research projects, they are not eligible for the various service benefits such as medical leave, gratuity etc. which other employees of these institutions get. Because of this situation, these institutions find it difficult to get competent staff to look after the sponsored research projects. Even those who are recruited feel insecure and unhappy since they are discriminated against.

4.11.2 It has been suggested that those institutions which have the competence to undertake research projects sponsored by outside agencies should be permitted to recruit and maintain a *core of competent scientific staff,* in the area of their expertise on a permanent basis with all service benefits. The expenditure in this regard should of course be a charge on the cost of the various projects and should be collected from the sponsoring agencies. It has already been suggested elsewhere in this report (4.10.4) that these institutions should be allowed to raise funds by charging the sponsoring agencies (including Government departments) 133 per-cent of the cost of the project.

4.12 Norms of assistance to post-graduate institutions :

4.12.1 One very serious deficiency of the post-graduate system in India is that the post-graduate courses in engineering and technology have been conceived narrowly, purely in terms of setting up of academic courses rather than fostering side by side the related R & D. Research activity cannot-should not- be divorced from post-graduate education. But this aspect has been largely neglected as is evident from the meagre norms of assistance hitherto given to these institutions.

4.12.2 It has already been pointed out (3.8) that the physical facilities available in many of the institutions are deplorable and that one of the main reasons for this is the poor norms for providing assistance to these institutions for introducing / conducting post-graduate programmes. These norms (placed at Annexure XII) were laid down in the 1960s and have now become totally unworkable particularly in view of the high rise in prices of equipment and materials. When these norms were originally prescribed, post-graduate studies were unfortunately regarded as an out-growth of and marginal support to under-graduate studies rather than post-graduate programmes in their own right. This is evident from the rather meagre and marginal assistance that was given-and is still being given-to conduct post-graduate courses. Consequently, post-graduate activities remain under-nourished and ineffective in all these institutions. The courses have remained simple academic exercises, unable to generate adequate R & D activities which are absolutely necessary to train competent engineers in areas of design, development and innovation. According to a document presented to the NCST in 1979, the annual investment in R & D in the U G C sector was only about 1.5% of the total S & T investment in the country.

4.12.3 A review of these norms was suggested in February 1979 by a Committee appointed by the Post-graduate Board. These revised norms are reported to be still under consideration of the Government.

It is necessary to take a closer look at this problem.

4.12.4 Non-recurring items

(1) **Buildings** : From the existing norms at Annexure XII it is clear that no building grants were given when post-graduate courses were sanctioned to institutions at different points of time. Over the years, this has resulted in a large number of institutions offering several post-graduate courses, when they do not have adequate space even to run their under-graduate programmes. A number of older institutions do not have even a proper seminar room with necessary facilities. This is really a pathetic situation.

It is necessary that whenever new post-graduate courses are approved, the space requirements including reasonable residential accommodation for faculty, should be taken into account for funding.

(2) **Equipment** : The norm for equipment is Rs. 1.5 lakhs per course. In April 1976, the expenditure Finance Committee modified this to Rs. 3.5 lakhs per course for equipment, library and buildings. This is totally inadequate.

While providing equipment facilities, the emphasis should be on creating core rather than specific facilities. Whenever new courses are approved, a ceiling of Rs. 5 lakhs per course may ordinarily be applied for equipment (including furniture). The new courses should be suitably incorporated with and into the existing programmes. Specific equipment facilites may be provided in exceptional cases under a ceiling of Rs. 2 lakhs based on specific research proposals. While considering such proposals, the credentials of the investigators (past and promise) should be carefully examined.

Every post-graduate institution should be provided with a mini computer at a cost of Rs. 5 to 15 lakhs. Post-graduate institutions should make the best use of the various national/regional facilities such as the Regional Sophisticated Instruments Centres (RSICs), Regional Computer Centres etc. set up by the Government of India.

The IITs should allow other institutions to use their computers on a non-commercial basis. It is also important to use computer time rationally. Now a lot of times is being wasted.

(3) **Library :** In view of the trenmendous explosion of knowledge and the very high cost of books, back volumes etc. particularly in specialised fields, it is essential to provide a non-recurring grant of Rs. 10,000/- per course subject to a maximum of Rs. 40,000/- for more than four courses.

A number of older institutions have hopelessly inadequate library facilities. Library buildings should be as far as possible independent buildings and support for this activity should be on a priority basis. Since it is difficult to segregate under-graduate/post-graduate demands, it is suggested that in the institutions where post-graduate courses are conducted, a space of atleast 2000 sq.m. for a total student population of one thousand should be sanctioned. In metropolitan cities, where a large number of people from industry use the library, the space may be increased to 2500 sq.m.

The library of every post-graduate institution should have alteast one xerox machine, one micro-film recorder and other audiovisual aids. An outright grant of Rs. 1 lakh should be provided for this purpose. It is suggested that a regional scientific/technical film library be located in each Regional Engineering College.

Books and journals are very costly. In many institutions unnecessary journals are ordered and also imported. This aspect should be carefully examined. Departmental libraries should only supplement and complement the main library. It was suggested that a single central agency may be asked to import all foreign journals.

Efforts should be made to cultivate library culture. Introduction of library projects should be encouraged. Inter-library loan scheme should be strengthened. Libraries should be kept open in the evenings and on holidays. At places like Oxford, library books are never loaned. However, the library is kept open throughout.

4.12 5 Recurring Items :

(1) **Teaching staff :** The provision for teaching staff should be based essentially on a department/institute basis rather than on a particular course only. The work load of existing staff should be first of all weighed before staff is sanctioned for a new course,

The existing norm of providing one Professor and one Assistant Professor /Reader per courae appears to be satisfactory. Obiviously, it is not meant that only these two teachers would run the proposed course. Other faculty members also are expected to help in conducting the programme.

However, in view of the high degree of specialisations involved in many areas at post-graduate level and since the faculty cannot be expected to be proficient and up-to-date in all these specialisations, it is necessary to provide adequately for lectures by visiting professors/experts from outside (industry, national laboratories etc.). For this purpose, a provision of Rs. 5000/- per year per course at the rate of Rs. 100/- per lecture should be provided. Moreover, if for any reason an institution is not able to fill a particular post-graduate faculty position for the most part of the academic year, it should be allowed to invite visiting faculty/experts from outside to deliver lectures. For making payment to them, the institution should be allowed to incur an expenditure of upto Rs. 5000/- per year per vacant faculty position.

2) Supporting staff : At present supporting staff are provided under a ceiling provision of 15 % of the expenditure on faculty. However, in deciding the admissible expenditure, this is taken (or interpreted atleast by the auditors) as 15 % of the actual expenditure on faculty in position. Thus, if any faculty positions are fully or partially vacant in a year, the admissible expenditure on supporting staff gets considerably reduced. This causes problems in creating and maintaining necessary supporting staff.

The insititutions should be allowed to incur an expenditure of upto 20% of the notional expenditure on sanctioned teaching faculty (not 20 per cent of the actual expenditure on faculty in position) on supporting staff (including Class IV staff, if necessary).

The recurring 100 % assistance for post-graduate courses (on faculty, supporting staff, library etc.) was until recently being sanctioned under plan account on a 5-year basis. Hence, the post-graduate faculty and supporting staff especially in non-Government institutions were not being categorically declared to be eligible for service benefits such as pension, gratuity/provident fund etc. as are applicable to the staff of undergraduate courses under State Government Grant-in-aid provisions. These uncertainties have affected the morale of staff and their service conditions.

Since non-plan provisions have been approved w e f. 1979-80 for meeting the recurring liability in respect of the on-going post-graduate programmes, the Central Government should advise the State Governments to extend retirement and other service benefits as per State Government rules to the staff of post-graduate programmes also.

(3) **Maintenance / Contingency grant**: The present norm of Rs. 1000/- per student for consumables, contingencies etc. is incredibly low, when one considers the high standards the post-graduates are expected to maintain particularly in their project/dissertation work. Several projects require computer time, which is very costly, and have often to be abandoned because of the restriction on expenditure. The costs of laboratory consumables, labour charges etc. for specialised work have also gone up.

It is suggested that the maintenance provision should be raised to atleast Rs. 3,000 per student per year for ME/M Tech. and Rs. 4,000 per student per year for doctoral candidates. This contingency grant may also be given to teachers (other than students) registered for ME/M Tech. and doctoral programmes.

The research scholars should be allowed to attend conferences within the country using the money from the contingency grant. Such expenses should not exceed Rs. 750/- per year for an M Tech student and Rs. 1,000/- per year for a doctoral candidate.

(4) **Library**: In view of the large increase in specialised technical books and publications, the ever increasing range of new subjects, the large number of electives to be taught, the considerable amount of references needed for study, research and thesis work, and the large number of periodicals and journals to be subscribed to, an amount of Rs. 10,000 per course subject to a maximum of Rs. 30,000 for 3 or more courses, should be provided as recurring assistance for library.

4.12.6 A summary of the revised norms suggested above is placed at Annexure XIII. It is emphasised that recommendation of grants for any new post-graduate programme should be based on the overall post-graduate activities of the departments concerned and not on a narrow truncated basis of specific post-graduate course/courses proposed by an institute, as has been happening so far.

4.12.7 While it is necessaty to undertake in a phased manner the need-based consolidation of all post-graduate institutions including modernisation of laboratories and replacement of obsolete equipment, it is strongly recommeded that such *need-based consolidation* be undertaken on a priority basis in selected institutions/departments, which, despite poor funding, have proved their merit by their past performance.

These institutions/departments should be subject to close scrutiny by competent Visiting Committees with a view not only to consolidate, but also to identify excellence they have by now achieved in emerging areas of national relevance and to promote them as Centres of Excellence/Advanced Studies. These centres should be adequately supported for studies/research at advanced level in the identified area. They should serve as nuclei for technological development in their respective regions. A provision of Rs 20 crores may have to be made for this purpose during the Sixth Five Year Plan (1980-85). If need be, even foreign technical assistance/aid may be resorted to for this operation. These centres should normally become self-supporting within 5 years after their establishment. Doctoral and p ost-doctoral fellowships should be instituted in these institutions on a regular basis.

4.13 Funding pattern, resources and financial Implications

4.13.1 At present there is no centralised authority for funding post-graduate courses in engineering and technology offered by various agencies. Of course, the funds come out of the Plan allocation given to the Ministry of Education under technical education schemes. However, the financing source varies according to the status and affiliation of the institutions. This has created lots of problems particularly to University Departments under the control of the UGC.

4.13 2 At present funding by the UGC follows more than one pattern. The first category would cover institutions like BHU—IT and the IISc Bangalore, where the UGC gives maintenance and development grants. No one also shares the cost.

Technological universities such as PAUT Madras, Jadavpur, Roorkee etc. set up by the State Governments come in the second category. In these cases, the UGC gives only development grants during a Plan period, the maintenance grants coming from the State Governments. Recurring liability

arising from the UGC assisted development is taken over by the State Governments after the Plan period. Norms prescribed by the Post-graduate Board may not strictly apply in these cases, they may be used by Assessment Committees.

In the third category come universities (other than exclusively technological universities) having Departments of Engineering and Technology in addition to other faculties. The UGC grants to such Departments of Engineering are normally regulated by norms prescribed by the Post-graduate Board.

4.13.3 The average post-graduate out-turn in the years 1976-78 was 2686 (3.1.1). This can be classified as below :—

1.	IITS	913
2.	RECs	282
3.	Govt. Colleges	193
4.	Non-Govt. Colleges	245
5.	Single faculty institutions	83
6.	University Institutions (including IISc Bangalore)	970
		2686

The out-turn under item 6 can roughly be sub-divided as follows in accordance with the three categories of UGC funding referred to in para 4.13.1 above :

(a)	first category	300
(b)	second category	450
(c)	third category	220

Serials at 1, 2, 5 and 6(a) are fully supported by the Government of India/UGC as the case may be and account for 1578 post-graduates. Serials at 3 and 4 are fully funded for post-graduate courses only by the Government of India and account for 438 post-graduates. Serial 6(b) stands on a better footing *vis-a-vis* 6(c), though in both cases the UGC grants are Plan period grants only.

4.13.4 The special difficulty of the institutions at 6(c) in getting grants from the UGC system was highlighted by a number of people. It is clear that a substantial part of post-graduate out-turn is from institutions receiving grants on a continuing basis from Central sources. If institutions falling in 6(b) and 6(c) are not to suffer in comparison, then the financial support from Central sources (Govt. of India/UGC as the case may be) should be on a continuing basis and not limited to Plan periods only.

The IISc having much in comparison with the IIT system rather than with any other system administered by the UGC, should rightly come under the Ministry of Education and be dealt with in exactly the same manner as the IITS In fact, the Chairman and the Director of the IISc are members of the Council of IITS.

If IISc is taken away, the remaining UGC funding for technical education becomes a small portion of its total budgetary operation, namely, about Rs. 3 crores out of Rs, 75 crores. It is also a small portion of the total Central Government spending on engineering and technology. The Ministry spent Rs. 26 crores on the IITS, Rs. 7.5 crores on RECs and Rs. 1.5 crores on grants for post-graduate courses in 1979-80. The total budget for technical education in the Ministry in 1979-80 was of the order of Rs. 48 crores.

Having regard to these, the funding for technical education (including post-graduate programmes) in the State Technological Universities and University Dapartments may become the direct responsibility of the Ministry. Only the funding in Central Universities may perhaps remain with the UGC but there must be a mechanism for consultation with the Ministry in regard to developmental inputs in technical education of the Central Universities.

4,13.5 The revision of norms suggested earlier is not the only item with financial implications. The investment in this programme (which fall short of Plan allocations from year to year) was about Rs. 1.5 crores in 1979-80. Very few new courses were sanctioned under this programme in the immediate past. The expenditure has, therefore, been mainly on continuation of the courses sanctioned earlier. The proposed revision of norms would approximately mean a doubling of recurring expenditure. If the revised norms are approved and no additional courses are sanctioned, the annual investment may rise to a figure of about Rs, 3.5 crores.

It has already been stated that, notwithstanding the developments that have taken place in post-graduate technical education since Thacker Committee Report, there is still a big gap to be made good, particularly in regard to the emerging areas. It has also been brought out that in India, for every 5 engineering graduates produced, only one seeks admission for post-graduate or research programmes, whereas in USA three out of 8 graduates pursue the post-graduate courses. The argument to strengthen the research and development base would as a corellary require situations to be created by which a greater number of engineering graduates pursue post-graduate and research work. This means that not only is a sizeable growth in post-graduate technical education necessary, but, taking a futuristic view, it may be necessary to enlarge the graduate base to make this possible. Thus there would be need for financial resources not only for additional investment at post-graduate level, but also in expanding the base at undergraduate level as supportive of the post-graduate level.

Financial resources would also be needed for setting up systems for continuous review of engineering/technical education with particular reference to post-graduate education, development of manpower information, surveys of manpower utilisation etc. as later suggested in the report.

4.13.6 There was a strong view that funding of post-graduate education and research in engineering and technology in all engineering colleges/ institutions including University Departments, RECs, State Government Colleges and non-Government Colleges should be a 100% Central Government responsibility and that the existing dichotomies/disparities in funding should be eliminated.

4.13.7 In the case of institutions of national importance, which are to be maintainad and further developed as pace-setter, funding should be based on integrated infra-structural development as at present. However, even in their cases, assistance to the various departments should be performance-based.

4.14 Institute-industry collaboration :

4.14.1 Experimental learning and practising can only be achieved if there is an environment of interdependency between professionals in the industry and professionals in the academic world. Professionals in the

academic world have to remember that the principal purpose of the educational system is to train and educate engineers for entry into the profession. At the same time, people in the industry must remember that the only sources of qualified manpower, which is the basic and the most important resource for industry, are the universities and institutions.

4.14,2 Institute-industry collaboration has been the theme of numerous studies, discussions, seminars and conferences not only in this country, but also elsewhere. It is not considered necessary to repeat and discuss them here. The Committee found that all forwardlooking educators and employers are not only conscious of the need for improving the quality and effectiveness of post-graduate education, but are also most willing to cooperate with each other to achieve this end for mutual benefit.

4.14.3 The following steps have been suggested to bring about close collaboration between institutions and industry:

(1) Faculty members should be required to spend not only their sabbatical leave, but also their summer in relevant industry. This will expose them to working of the industry and building up of close relationship with those in the industry. An added advantage would be teachers bringing back information on research and development in the industry and also data on live problems. The Committee was surprised to hear that the 'National Associateship' scheme' of the UGC which enabled teachers to spend upto 12 months in industry was not being utilised by the engineering faculty members.

(2) Institutions should involve industry in the development of curricula on a regular and continuing basis. Curricula should be dynamically designed and should be flexible enough to permit changes to include new ideas and developments in the relevent subject areas. In many advanced countries, Pust-graduate syllabus is reviewed and up- dated every year.

(3) Institution should contribute towards continuing education of practising engineers by giving courses in the 'state-of-art' as well as on advanced topics. Specific modules of training programmes should be introduced for railways, defence services, posts and telegraphs etc. Seminars and symposia of 1to 2 days duration are not of much use and should be discouraged. To be meaningful, the duration of the courses should not be less than 2 months. They should be designed for personnel at various levels. Here it may be pointed out that the MITs' Centre for Advanced Engineering Study accepts persons even at the level of

Chief Engineers/Directors. The Participants are in residence for 2 semesters or so. Similarly, the General Electric Company runs a course of 9 months duration for senior executives of the electric utilities. Institutions should also design and provide self-programmed courses to update the knowledge of practising engineers. The cost for running these courses should be met by industry on a 100% basis.

(4) Sandwich cooperative courses at M.Tech. level are being successfully offered in advanced countries and particularly in the United States. The MIT has a cooperative course with General Electric, Bell Telephones, RCA, IBM and others. After the first year at the institutions, students spend alternate semesters with the chosen industrial unit.. At the end of 6 years, students get master's degree from the institution and employment with the industrial unit with which they had spent alternate semesters.

The industry-oriented M.Tech. Programme introduced in some of the institutions in India were well-conceived, but badly executed mainly because of lack of proper cooperation from industry. These courses should be fine-tuned and toned up with a view to make them effective. Here mention may be made of the 'practice school programme' and 'post-graduate collaborative programme being offered by the BITS, Pilani.

(5) Eminent educationists/academicians should be put on the Board of Directors of industrial undertakings and leaders in industry should be placed on the Boards and Advisory Bodies of educational institutions. The institutions in India can take a lesson from American universities, which keep track of their Alumni and involve them in their work on a continuing basis.

(6) The industry should refer their live problems to educational institutions. These problems should be given as projects for M.Tech./doctoral programmes. The entire costs of these projects should be met by industry. The industry should also come forward to institute fellowships/chairs in educational institutions for specific tasks.

(7) Senior profossionals in industry should be invited to give lectures/ specific courses at post-graudate level. In fact, at post-graduate level, institutions should have only a core faculty; others should be "Visiting Faculty", from industry and R & D organisations. In countries like France

almost all teachers at post-graduate level are ,,Visiting Faculty'' from industry. Institutions also do not keep expensive sophisticated equipment. They are kept and maintained in R & D organisations/industry.

(8) Educational institutions should be encouraged to generate their own resources in collaboration with industry. It is well-known that some American universities have long cultivated links with industry. For example, there are high-technology, venturecapital companies spawned by campuses in California and Massachussetts. The California Institute of Technology even sends scientists out to canvass contract work by alerting industrialists to the resources and skills it has. The 'teaching company scheme' of UK is worth trying in India. The Chemical Engineering School of the University of Paravia (Brazil) operates a number of semi-commercial plants geared to production processes.

(9) A 'Research cess' should be levied—if necessary, through legislative action—on every production agency. The fund so collected should be placed at the disposal of an independent authority to be utilised for post-graduate education and research. Decisions on the utilisation of this fund should be taken with the active participation and involvement of industries.

Regular long-term post-graduate progromme suggested by industry jointly or otherwise should be financed by industry atleast on a 50% basis. Shoft-term courses suggested by industry should be financed by them on a 100% basis. A 133% tax deduction should be allowed on all payments contributions / investments made by industry in post-graduate education and research (this should include educational endowments, fellowships etc.). Today, industry's investment in education is very little. Therefore, incentives, directives and legislative measures are called for to ensure industry's involvement in post-graduate education and research.

(10) It would be good to club / link industries to educational institutions. Industries may be encouraged to set up R&D production units in academic institutions. The Bandung Institute of Technology has set up an Institute for Application (LAPI) to coordinate research with industry. The Colgate industry has set up an industrial research centre in an academic campus.

(11) Industrial establishments should examine how to strengthen their access directly and indirectly to teaching / research institutions with a view to make better use of the resources and expertise available with the latter. They should ensure that they are making better use of the consultancy

and research services offered by the teaching / research institutions. A tax should be levied on any knowhow imported.

4.15 Post-graduate programmes in 'applied sciences'. technology courses, need for re-structuring science and engineering courses

4.15.1 Post-graduate courses in 'applied sciences' now being offered in most places are not of good standard. They should be critically reviewed.

4.15.2 Some of the emerging areas, though science based, are heavily technology oriented. Examples are: computer science, opto-electronics, operation research, laser technology etc. In these areas, there is urgent need to train scientist-technologists who can handle the twin responsibilities of scientific research and innovative application. The traditional framework of engineering programme is inappropriate for this purpose and a separate stream of post-graduate courses of 3 semesters duration after MSc in science has to be developed on the pattern of ME / MTech programme suggested in this report. These courses should be introduced only in selected engineering / technological institutions having adequate infrastructural facilities. Such courses which are already existing should be re-structured to make them more application-oriented.

4.15.3 There are a few universities in India which have been conducting courses in different branches of technology such as textiles, plastics, paints, leather etc. which have proved to be useful and popular. These courses at many places are of 3 years duration after B.Sc. and lead to the degrees of the BSc(Tech). MSc(Tech) courses in many of these branches have also proved to be useful. In view of the changed pattern of school education (10 + 2 system), these courses will need re-structuring from the point of view of duration.

4.15.4 This brings us to another issue : the difference in the status of science and engineering degrees. At present an MSc degree in science is often equated to a BE degree in engineering. This equation is mainly done on the basis of the total number of years required to take the respective degrees. In view of the changes taking place in the pattern of education, it is advisable to take steps to re-structure the courses in such a way that degrees in science can be equated to the corresponding degrees in engineering. This would also facilitate quick and easy mobility from science to engineering/technology and *vice versa*.

4.16 Part-time and off-campus post-graduate programmes

4.16.1 There is increasing demand for part-time (evening) post-graduate programmes specially in industrialised areas in the country. Some institutions came forward to say that they would prefer to close down their regular programmes and offer only part-time evening programmes, since the latter were not only more popular but also more effective. It is suggested that introduction of part-time post-graduate programmes should be encouraged but strictly on the following conditions :

(1) The courses should be organised only in subject fields in which full-time master's degree courses are already offered by the institution and infrastructure by way of building, equipment and staff is already available. In exceptional cases, if conditions warrant, these courses may be introduced even if full-time post-graduate programmes are not offered in the subject areas concerned. In such cases, it should be ensured that the concerned institution has a strong under-graduate base in the relevant subject area and has developed an industry culture by establishing cooperative relationships with industry.

(2) The course should be exclusively meant for working engineers sponsored by their employers. The sponsored candidates should have at least 2 years working experience.

(3) The subject field and the course contents should be determined in collaboration with the industry/government undertakings, government departments and other agencies sponsoring the candidates.

(4) The intake to each such course should be 5 to 10 and no course should be started with an intake of less than 5.

(5) The duration of part-time post-graduate degree courses should be 5 semesters and should be offered in modules with credit system.

(6) Since the courses are to be offered on part-time basis and only in institutions where physical facilities are already available, no additional permanent facilities such as building, staff etc. need be created. The courses should be run on a self-supporting basis charging the sponsoring agencies wherever additional inputs are necessary.

(7) since the participants would be sponsored by their employers, no scholarship would be available to the participants.

4.16.2 In some of the advanced countries—notably the United States-well established university/engineering institutions offer off-campus part-time post-graduate programmes in industrial areas located far away from the campus. These programmes are subject to the same regulations as on the main campus and students are admitted through the same procedures and according to the same standard as on the main campus. Needless to say that the matter of academic standards in part-time programmes especially at off-campus locations warrant special attention. There is a real opportunity for innovation to facilitate high quality off-campus instruction in India. It is suggested that new techniques and arrangements be devised for extending high quality post-graduate education to engineers/technologists employed at locations remote from established campuses.

4.16.3 It has been suggested that institutions like the IITs should paly a leading role in organising part-time and off-campus post-graduate programmes.

4.17 Continuing Education programmes :

4,17.1 It has been said that engineering is a learning profession rather than a learned profession. No engineering education anywhere in the world can presume to teach students "all they need to know". An engineer must continue to develop throughout his working life; gain familiarity with new areas as they develop and discard old ones as they become irrelevant. Therefore, engineering profession and academic institutions which serve it must look forward to a growing activity in continuing education programmes as a distinct educational function, outside regular post-graduate programmes. The objective of continuing engineering studies is the specific enhancement of the individual as a practising engineer, rather than the attainment of an additional academic degree or diploma

4.17.2 The Government and industry must work together within a major national programme of training and re-training of engineers and tecnologists of all ages and at all levels to develop the skills and support needed to implement and sustain new technologies. The employers should support and facilitate in every possible way employee participation in continuing education programmes, refresher courses etc. A Dean (Industrial Liaison) should be appointed in each post-graduate institution to take care of these programes.

4.17.3 These short-term programmes/refresher courses which will not lead to any degree or diploma should be conducted more or less on the basis of the first 4 norms/guidelines mentioned (in 4.16.1) for introducing part-time postgraduate degree programmes. They should be self-supporting. The

necessary financial inputs should coma from the industry/agencies sponsoring the candidates.

4.17.4 Efforts should be made to evaluate and promote the initial trial and expansion of 'distance learning' methods as vehicles for continuing education programmes for engineers.

4.17.5 While assessing staff requirements of institutions, full account should be taken of the importance of allowig adequate senior staff time for building up their activites in continung education programmes. The continuing education of practising engineers has another advantage. It brings the teachers into repeated contact with people on the job and helps to make their teaching and research more purposeful.

4.18 Administration and control of post-graduate programmes, performance audit

4,18.1 In 1953, the AICTE appointed a standing committee known as 'Postgraduate Development Committee" to formulate schemes for the development of post-graduate courses and research in technological institutions. The appointment of this Committee gave an impetus to developments in this field in various institutions.

4.18.2 In 1961, the Thacker Committee felt that the organisational aspects of post-graduate programmes should be dealt with in a more realistic manner in order to exercise an effective control over post-graduate activities and recommended the establishment of the All-India Board of post-graduate Engineering Studies and Research to coordinate the development of post-graduate education and research in engineering and technology in the country and to advise the AICTE as to how and where facilities for post-graduate education and research should be provided and what assistance should be given for this purpose by the Central Government.

4.18.13 Accordingly, the Post-graduate Board was set up under the aegis of the AICTE in 1962 and it continues to function. The terms of reference of the Board are :

1. To co-ordinate the development of post-graduate education and research in engineering and technology in the country.

2. To formulate a detailed plan for the development of post-graduate education and research during each Plan period.

3. To lay down the standards and fields of study and to ensure that correct standards are maintained.

4. To advise the All India Council for Technical Education on how and where facilities for post-graduate education and research should be provided and what assistance should be given by the Central Government for the purpose.

5. To make a survey of the needs of research, design and development engineers in various specialities in the country and to formulate programmes to meet the requirements of such personnel for industry, research laboratories and technical institutions,

6. To promote collaboration between technical institutions offering post-graduate programmes on the one side and research laboratories and industry on the other.

4.18.4 Though the Post-graduate Board played a prominent role in coordinating post-graduate education and research all over India in the first decade of its establishment, its performance during the past few years has been far from satisfactory. It did not meet for years together. It did not have—and still does not have—a separate and competent Secretariat with adequate supporting staff to deal with the numerous problems of coordination and administration of post-graduate programmes and research. Consequently about Rs. 13 crores allocated for the development of post-graduate education and research during the Fifth Five Year Plan could not be utilised. The damaging impact of this lapse on post-graduate education and research in engineering and technology is bound to be felt for many years to come.

4.18.5 Post-graduate education and research in engineering and technology is too serious a matter to be neglected like this. In its 40th Report, the Estimates Committee of Parliament had observed significantly that as an advisory body the AICTE (under the aegis of which the Post-graduate Board is functioning) had not been effective in bringing about the much needed improvement in the quality and standard of technical education and recommended that an agency with suitable administrative, executive and financial powers should be set up for the development of technical education in the country.

Reviewing the status of technical education in the country, the Working Group on Technical Education appointed by the Government of India in 1977

strongly recommended that the AICTE be vested with statutory powers for ensuring effective implementation of policies and programmes and maintenance of standards. It is suggested that this be done without any further delay. Introduction of post-graduate programmes should be strictly coordinated by the Post-graduate Board even if the State Governments' institutions do not ask for funds.

4.18.6 Evaluation and accreditation of engineering courses is done in advanced countries. In the United States, accreditation is of two kinds: institutional (or general), in which the total capability of the College or institution is involved, and curricular (or special) in which the capability in a particular field of study is the focus.

The Finniston Committee has recently (January 1980) recommended to the British Government that "specific and long-term additional funding should be earmarked.....for the establishment and maintenance of accredited BEng and MEng courses; courses which failed to get or lost accreditation by the Engineering Authority should not be eligible for these earmarked funds". Institutions failing to meet basic standards should be stripped of financial support.

4.18.7 Many who gave evidence before the Committee stressed the need for establishing a National Evaluation and Accreditation Agency. The Working Group on Technical Education has also made a similar recommendation. Evaluation and accreditation of post-graduate courses should be done atleast once in five years.

4.18.8 It was suggested that the system of utilisation of grants to post-graduate education and research should be examined. The procedures adopted for audit are out-of date and inappropriate for educational and research institutions. Methods should be developed for the performance audit of institutions engaged in post-graduates education and research to facilitate comprehensive reviews of various programmes. The general practice of financial expenditure audit should be done away with.

4.19 Lack of data banks and information servies

4.19.1 Scientific and technological data/information are an essential resource for higher education and training, advancement of S & T and their application to the economic, social and cultural development of a country. One of the biggest stumbling blocks in the path of scientific and technological research and development in India has been - and is - the lack of proper data

banks/information services. The result has been: useless repetition of research resulting in wastage of scarce resources and inability to benefit from knowledge lying 'buried out of sight'.

4.19.2 Even the limited resources that are available in our libraries and documentation centres are not being used effectively. They are mostly unused or underused. Users lack knowledge of the ever increasing varieties of information, products and services and the skills in making effective use of them. It has been rightly said that how a country handles its data will soon be more important than how it handles its oil, coal or natural gas.

4.19.3 There is immediate need to educate and train information users by introducing user education/training programmes in the post-graduate institutions and research centres. The users should also know that information is a commodity worth paying for. Agencies such as INSDOC and NISSAT should give guidelines to:

(1) design and develop slide-cum-tape training package for different levels at the universities, IITs, research organisations and similar other institutions;

(2) train appropriate personnel for imparting instructions and conducting the programmes; and

(3) implementing the programmes as a regular part of university courses, and in research oaganisations as a part of information services.

4.19.4 The rapid advances in informatics, communications and related information handling technologies have become an important factor in the design and implementation of information systems and services. All the experience in this area has been mainly in the west and largely on the creation of bibliographic data bases, most of which are based on traditional abstracting and indexing services. India has started importing these data bases along with the appropriate software to develop a computerised information retrieval system in the country. Not only is it necessary for India to absorb this imported 'information technology' to have an information network, but also to develop her own to suit local needs. The IITs and other institutions of higher learning and research establishments have all the required potentialities of men and material to initiate research projects in this area.

4.19.5 While the basic access services to scientific and technological information have been provided through indexes and abstracting tools by

librarians and information specialists, consolidation services like critical reviews, state-of-art/trend reports have been lagging behind. The production of these tools demand a high degree of subject specialisation and skill in technical writing. Consolidating, reviewing and interprating the literature are demands considered worthy of the efforts of the most gifted scientists and engineers. The production of a truely creative review, which synthesises data from more than one field and ties seemingly unrelated areas together in a meaningful relationship, is a rare and valuable contribution.

4.19 6 One importamt approach to information is computerised information retrieval. Concerned with the rapid development of data banks in the US, UK, and FRG and the fact that French scientists were making about 60,000 calls to use data banks annually at a cost of 15 million francs. France has recently (June 1979) set up a new National Data Centre at Vallbonne near Nice with the purpose of providing French scientists with bibliographic information produced by the world's major documentation services. With a capacity of 10 billion bytes, the computerised system will allow access on-line to about 10 million references. This centre was established in a record time of 6 months at the special request of the French President, Giscard d'Estaing.

4.19.7 It is suggested that there should be a couple of such centres in India which should get all the major data bases of science and technology in the form of computer readable magnetic tapes and act as a data bank. The system of providing scientific information started by INSDOC in 1977 under the UNESCO supported project on 'Selective Dissemination of Information (SDI)' has to be considerably expanded.

4.20 Linking postgraduate training and research with development and engineering schemes:

4.20.1 The need for making post-graduate training and research to the needs of the country were highlighted by almost all who met the Committee. Most of the suggestions made in this regard have already been discussed in the preceding sections.

4.20.2 The Post-graduate Board—suitably strengthened and re-organised with statutory powers as indicated earlier (4.18.5)—should play a vital role in linking post-graduate training and research with major developmental and engineering schemes by liaising effectively with national agencies such as the NCST, Planning Commission, Department of Economic Affairs, UPSC etc.

There are already instances of some of the national laboratories and public sector undertakings closely collaborating with academic institutions in

conducting post-graduate programmes and research in relevant areas. The Central Leather Research Institute at Madras and PAUT Madras are together running a post-graduate department in leather technology. The Bharat Heavy Electricals Limited are collaborating closely with REC Tiruchirapalli. The defence organisations have strong linkages with many of the higher technological institutions. This sort of linkages should be encouraged, further developed and legitimised.

4.20.3 A recent report on industrial R & D prepared by the DST present a picture of imbalances and the private industry's inability to respond to R & D despite Governmont incentives. In the public sector also R & D activity was concentrated in a few areas and the base of the growth of the R & D expenditure as compared to sales turned over was very low.

4.20.4 It has been suggested that all developmental projects and industrial expansion should be linked up with induction of competent post-graduate engineers and technologists into the establishment. Both public and private sector undertakings should be asked to institute regular "engineering manpower audits", building upon best employment practices in this country and overseas to ensure that they are making the best use of post-graduate engineers as their key assets within the engineering dimension. Proper utilisation and deployment of manpower is most important. There is need to take effective action in the matter.

4.20.5 A strong suggestion has been made that a Quality Improvement Programme should be established for working engineers in industry and government departments (on the pattern of the QIP scheme for the teaching faculty in engineering institutions) to enable them to go for post-graduate training and research in the relevant areas.

4.20.6 Some industries organise training programmes for their employees in countries abroad. Such foreign training programmes should be carefully scrutinised and reviewed. People should be sent abroad for training only in specific areas where facilities are not available within the country. Even in emerging areas, it is possible to give major part of the training in India. Such preparatory training in the country would greatly enhance the benefits from foreign training inputs.

4.21 National manpower information system

It has already been mentioned (1.4.4) that a reliable manpower information system is a pre-requisite to planning; especially in the field of technical education and training. In the absence of such an information system, it has not been possible to anticipate areas of growth and to plan for

technical manpower development. Some occasional work on manpower information/assessment had been done by the Institute of Applied Manpower Research and some other agencies, but not on a regular and continuing basis. Discussing this issue, the Working Group on Technical Education had stressed the need for establishing a reliable national information system for the storage, updating, retrieval and analysis of manpower information to assist technical education planning. Action on this recommendation, which is particularly relevant in the case of post-graduate education planning, should be taken as a matter of urgency. It is also suggested that future official census surveys should be suitably structured to collect the information necessary for the maintenance of a continuing national inventory on engineering manpower.

4.22 Policy for training overseas students, technical co-operation among developing countries.

4.22.1 India has a leading role to play in the new concept of "Technical Cooperation among Developing Countries" (TCDC). Apart from putting large numbers of Indian scientists, engineers and technologists at the disposal of many other developing countries, India is giving training facilities for thousands of overseas students. While most of the advanced countries have clear-cut policies for training overseas students, India has not yet formulated any such policy. Consequently several problems have arisen.

4.22.2 There is increasing pressure on India from many countries for training facilities in engineering and technology especially at advanced levels. Even some of the advanced countries have come forward to fund the training of students from Third World countries in India. These developments have added a new dimension to the whole problem of training overseas students. It is in the interest of India to formulate a coherent 'country training policy' for training overseas students. While doing so, the special needs and requirements of the countries concerned should also be taken into consideration.


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5.0 FINDINGS AND RECOMMENDATIONS

Previous reviews, need for re-organisation :

5.1 The role of scientists, engineers and technologists in helping to meet the changing needs of the country coupled with the extended time and high cost involved in their training, requires that continuous attention be given to present and future trends and patterns in the production of such personnel. (1.1.1, 1.4.4 and 1.4.5)

5.2 This report is the latest in a series of official reports on post-graduate education and research in engineering and technology. All previous reports made many practical recommendations which are valid even today after many years since their issue. Unfortunately there have been short-comings in implementing them, which have resulted in the unsatisfactory state of affairs of post-graduate education and research today. (2.1—2.5)

Present status :

5.3 As at present, India produces about 350 doctorates, 2700 MEs/MTechs and 16500 graduate engineers (in the ratio of about 1:8:47) annually, whereas annual intake provisions are about 500, 6000 and 26000 (1:12:52) respectively. About 70% of the PhDs and 44% of the MEs/MTechs are produced by the 5 IITs and IISc Bangalore. (3.1.1, 3.1.4. and 3.4.4)

5.4 Today the S & T content in the Indian society and the extent of India's involvement in R & D are very low. The number of scientific and technical personnel in India per thousand of population is only 3.8, whereas it is 12 in the United States, 19 in the FRG, 82 in the USSR and 185 in Japan. Scientists and engineers engaged in R&D in India per thousand population is only 0.09, this figure being 2.68, 2.97, 3.72 and 4.98 in the United States, FRG, USSR and Poland respectively. The Indian expenditure on R&D which was 0.23% of GNP in 1958-59 has risen to 0.6% of GNP in 1976-77. The expenditure on R&D as a percentage of GNP was 2.1 in UK (1972), 2.3 in FRG (1974), 2,3 in the United States (1975), 2.5 in Japan (1975) and 2.7 in Poland (1975). (4.1.1—4.1.4)

5.5 The performance of a few institutions in the area of post-graduate education and research has been quite good mainly because of deliberate efforts and liberal investments in promoting them.

In spite of the considerably lower inputs, about 20 other institutions have also done creditably well. The performance of the remaining 50 or so

institutions is poor, even though some of them have succeeded in developing some areas / disciplines well: The physical facilities such as faculty, accommodation / space, equipment and in library in many of these institutions are to be considerably improved. (3.1—3.8)

5.6 The capacity for generating and sustaining technological growth within the country has to be strengthened considerably and vigorous steps taken for the continual improvement of that capacity. Since the total stock of India's S & T manpower is quite small relevant to her population and corresponding national needs, this stock will have to grow at a faster rate - particularly in quality - during the coming decades. Therefore, the Indian national investment in scientific and technical education and research should increase many fold to meet the growing needs of the changing social system. (4.1.2 and 4.1.5.)

Admission policy, scholarships :

5.7 For a variety of reasons which include redundant and outdated courses, inadquate facilities, lack of motivation long duration of courses, lack of recognition and incentives, ineffective administration of the programmes, etc., it has not been possible to attract sufficiently large number of bright young people for post-graduate education. This is a serious matter which will have far reaching consequence on the future technological competence of this country. (4.4.1 and 4.4.2)

5.8 Strong and firm measures as suggested in this report should be taken to ensure that only bright and motivated people are admitted to post-graduate programmes. Admission to post-graduate programmes should be restricted to only those who come through the GATE, The Government should consider imposing requirements on industry and Government departments to sponsor their engineers for post-graduate education and research in the respective areas of their interest. If necessary, upto 50% seats should be reserved for sponsored candidates (4.4.3 and 4.14.3)

5.9 Post-graduate scholarships for ME/MTech should be enhanced from the present value of Rs. 400 per month to Rs. 600 per month and should be given to all those who are admitted through the GATE. However sponsored candidates, who get paid, would be eligible to get only 75% of the value of scholarship. Felloships for doctoral aspirants should be raised from the present value of Rs. 500 p.m. to: 1 st year Rs. 700 p.m., 2nd year Rs. 800 p. m. and 3rd year Rs. 900 p.m. The fellowship value should be enhanced by Rs. 50 after submission of the thesis and should be continued for 3 more months or till the *viva* is over, whichever is earlier.

Values of all scholarships/fellowships should be reviewed once in every three years. (4 3.8)

Restructuring, re-organisation, new courses :

5.10 The post-graduate diploma courses have not been found to be popular and successful in most institutions. It is felt that they need not be offered as regular programmes unless some of them are specifically asked for and paid for by the interested agencies (3.2.2, 4.5.1 and 4.5.2)

5.11 All existing post-graduate degree programmes which are outdated stereotyped and unpopular should be wound up. Wherever possible, attempts should be made to redesign the existing courses to include relevant and emerging areas. Narrow and futile definitions of disciplines are dangerous. Care should be taken to see that inter-disciplinary areas encourage active cooperation among related departments and programmes of teaching and research are run jointly.

5.12 There are variations in the structure and requirements of existing post-graduate programmes, which have resulted in large differences in standards and quality of post-graduates produced. These have to be streamlined as suggested in this report.

All ME/MTech programmes should be of three semesters duration consisting of 2 semesters course work including core and elective subjects and one semester of dissertation work. The dissertation should offer an opportunity for the candidates to engage in a creative and self-learning experience. It should be either design oriented. The topic of the dissertation should be as far as possible trans-disciplinary in nature. The concept of joint guides for supervising project/dissertation work can have a very positive impact on the post-graduate education system and hence should be encouraged.

(3.2, 4.5.2 and 4.5.3)

5.13 The ME/MTech programmes should be offered in suitable modules with credit system. This re-structuring of ME/MTech programmes should be undertaken as a matter of urgency in close collaboration with people from industry, R & D organisations and others concerned. It is also necessary to set up post-graduate Curriculum Development Centres to revise, redesign and update the curricula of post-graduate programmes on a continuing basis as suggested in this report,

While restructuring the ME/MTech programmes, it should be clearly remembered that they are to prepare persons of high quality and calibre for all engineering functions including design, development, technology assesment

and transfer, management, research, etc. An individual department/institution may wish to emphasise one or more of these functions depending upon the kinds of faculty, students and facilities it has. (4.5.3, 4.5.4 and 4.3)

5.14 Doctoral work should be regarded as preparation for the highest levels of creative leadership in all areas of engineering practice including teaching and research. The minimum duration for doctorate after ME/MTech should be two years. In exceptional cases, when BTechs are allowed to register for doctorate, the minImum duration for doctorate should be three years; In either case, fellowship would not be paid for more than four years. All aspirants for doctorate should invaribly go through some advanced courses relevant to the thesis. "Candidate-based" Doctoral Committees should assess the candidate's competence and identify his deficiencies. The course work for doctoral programmes should be revised and updated every year.

A critical aspect of the doctoral requirements has to be the thesis, which should provide an important creative experience to the candidates. The successful completion of this creative experience should make the doctoral programme a valuable career preparation. Innovation, originality and practical/ social relevance should be the hall-marks of doctoral work.

The policies for recognising supervisors for guiding doctoral candidates should be made uniform. There are wide disparities at present. (4.5 5 and 4.10.5).

5.15 Post-graduate courses in 'applied sciences' now being offered in most places are not of good standard. They should be critically reviewed.

In view of the changes taking place in the pattern of education system, efforts may be made to re-structure the science courses so that the science degrees are comparable to the corresponding degrees in engineering/technology. In many of the emerging areas, which are science-based but heavily technology oriented, there is need to train scientist-technologists who can handle the twin responsibilities of scientific research and innovative application. The traditional framework of engineering programmes is inappropriate for this purpose and a separate stream of post-graduate courses of 3 semesters duration after MSc in science has to be developed on the pattern of the ME/MTech programmes suggested in this report. These courses should be introduced only in selected engineering/technological institutions/university departments having adequate infra-structural facilities. (4.15.1—4.15.4)

5.16 In view of the limited resources available and also the need to maintain high standards, sanctioning of post-graduate courses has to be done with utmost care on the basis of the criteria mentioned in this report. Under no circumstances should further proliferation of existing programmes in conventional or irrelevant areas be permitted. Empire building within institutions and between institutions should be discouraged. Neighbouring institutions including national laboratories and others should be encouraged not only to conduct post-graduate programmes jointly, but also to share facilities such as faculty, library, equipment, etc. jointly. (4.7.1 and 4.7.2).

Part-time courses, continuing education programmes:

5.17 There is increasing demand for part-time (evening) post-graduate programmes especially in industrialised areas in the country. It is recommended that introduction of part-time post-graduate programmes on the basis of the guide-lines mentioned in this report should be encouraged. There is a real opportunity for innovation to facilitate high quality off-campus instruction in India. It is suggested that new techniques and arrangements be devised for extending high quality post-graduate education to engineers/ technologists employed at locations remote from established campuses. (4.16.1 and 4.16.2).

5.18 Institutions like the IITs should play a leading role in organising part-time and off-campus post-graduate programmes. Needless to say that matters of academic standards in part-time programmes especially at off-campus locations warrant special attention. (4.16.1—4.16.3)

5.19 Engineering profession and academic institutions should look forward to a growing activity in continuing education programmes as a distinct educational function outside regular post-graduate programmes. The Government and industry should work together within a major national programme of training and re-training of engineers and technologists to develop the skills and support needed to implement and sustain new technologies. It is recommended that a Dean (Industrial Liaison) be appointed in each post-graduare institution to take care of these programmes. (4.17.1—4.17.4)

5.20 While assessing staff requirements of institutions, full account should be taken of the importance of allowing adequate senior staff time for building up their activities in continuing education programmes. (4.17.5)

Employment potential, manpower planning, manpower utilisation :

5.21 It is necessary to recognise publicly and to publicise more widely that in today's world post-graduate studies at master's degree level are a

normal part of basic engineering education. The unreasonably restrictive conception that a bachelor's degree is sufficient preparation for most engineering work should not be perpetuated. It is a sad situation that today of the total S & T manpower employed in the public sector R & D organisations in the country, only 2% are PhDs and 12% MEs/MTechs in engineering. In the private sector these figures are 1% and 9% respectively.

A sustained national programme should be launched to stimulate more widespread understanding among employers of the nature and importance of the engineering dimension and of the potential benefits to them from employing post-graduate engineers in a wide range of activities. Employing organisations should review their salary and career structures for engineers to ensure that they adequately reflect a value for post-graduate engineers' contributions. (4.2.1 and 4.2.2)

5.22 It should be made mandatory to prescribe post-graduate degree as the minimum qualification for recruitment to many positions in the engineering profession in industry, R & D organisations, Electricity Boards, PWDs, P & T, Railways, etc.

It is high time to do away with the present policy and practice of regulating graduate engineers at the lowest levels (single point entry) to many services. As an incentive and mark of recognition, it should be mandatory to give not less than two extra increments whenever post-graduate degree holders are recruited. A suitable number of advance increments should also be given to doctorate degree holders. (4.2.3)

5.23 The proposed National Authority – suitably strengthened and reorganised with statutory powers as indicated in 5.48-should play a vital role in linking post-graduate training and research with major developmental and engineering schems by liaising effectively with national agencies such as the NCST, Planning Commission, Department of Economic Affairs, UPSC, etc.

The Government should take every possible measure to link up all developmental projects and industrial expansion with the requirement of induction of competent post-graduate engineers and technologists into the respective projects. Both public and private sector undertakings should be asked to institute regular 'engineering manpower audits' building upon the best employment practices in this country and overseas to ensure that they are making the best use of post-graduate engineers as their key assets within the engineering dimension. Proper utilisation and deployment of scientific and technical manpower is most important. (4.20.1—4.20.6 and 4.18.5)

5.24 It is recommended that a reliable national information system for the storage, updating, retrieval and analysis of manpower information should be established to assist technical educational planning. It is also suggested that future official census surveys should be suitably structured to collect the information necessary for the maintenance of a continuing national inventory on engineering manpower. (1.4.4 and 4.21)

5.25 It would be worthwhile to study the employment pattern of post-graduate in industry, government, education, etc. and also to make inter-comparisons regarding their characteristics, attitudes and performance. Information on the relevant numbers of engineers, technologists engaged in various functions such as design, operations, production, research development, management, teaching, etc. would be a useful guide to engineering educators and planners. The industry, educators, government and others concerned should join hands and together undertake this survey as a matter of urgency. (1.4.5)

Faculty Improvements

5.26 Next to the student body, the faculty is the most important factor in assuring success of any engineering education programme. The Committee received numerous complaints relating to indifference and incompetence, incorrect attitudes and inadequate aptitudes, etc. on the part of teaching faculty. It was also pointed out that a tendency to inbreeding even in our national institutions has brought down the calibre of teachers and the level of post-graduate education. Mobility and exchange of faculty between academic institutions, R & D organisations and industrial establishments should be encouraged to prevent inbreeding. Industrial experience should be prescribed as an essential qualification for teaching positions at post-graduate level. Technical competence, scientific understanding, creative ability and humanistic wisdom should be the requirements for teachers particularly at post-graduate level. (4.8.1 and 4.8.2).

5.27 Possession of a doctorate degree or equivalent qualification representing an advanced level of intellectual attainment and creative endeavour should be made a pre-requisite for post-graduate teaching. Educational institutions, engineering profession, industry and Government should jointly develop a variety of programmes designed to enhance the development of engineering faculty members as practising engineers through the effective use of study leave, summer training, consulting and research opportunities. (4.8.3).

5.28 The recruitment to teaching positions at all levels should be made only on an all-India basis after close scrutiny of the competence and

qualifications of the candidates *vis-a-vis* the prescribed job requirements. TA/DA should be given to all those who are called for interview. A rigorous 'staff appraisal scheme' to assess the teacher annually in the area of teaching, laboratory work, research and publications should be introduced in every post-graduate institution. Staff appraisal records (these are different from confidential reports) should be looked into at every stage of promotion. Suitable merit promotion schemes should be introduced in engineering colleges/institutions. (4.8.4 and 4.8.5).

Equipment maintenance, training in instrumentation :

5.29 In almost all post-graduate institutions, including institutions of national importance, many items of costly and sophisticated equipment are neither maintained nor utilised properly. A specialist cadre of maintenance technicians/engineers with proper status and attractive scales of pay should be built up at least on a regional basis. Meanwhile, a small team of competent instrument mechanics experts should be asked to examine the sophisticated equipment now lying idle in the various post-graduate institutions with a view to set them right. (4.9.1—4.9.4).

5.30 It is necessary to create in some of the institutions an infrastructure for training in the instrumentation area with particular reference to repairs and maintenance of sophisticated equipment. Institutions like the IITs should ensure that they are capable of maintaining and repairing their own equipment and those of others in that region. Instrumentation is becoming more and more complicated and sophisticated incorporating latest technologies. Huge and costly facilities are indispensable to carry out research in many new emerging areas. In view of the limited resources and to facilitate proper maintenance, it is advisable to create some more centralised facilities at a few more centres of Excellence identified for advance research in these emerging areas. (4.6, 4.9.5 and 4.9.6)

Institution-Industry collaboration :

5.31 The Government should consider imposing requirements on industry as well as on post-graduate institutions to collaborate with each other on the basis of the various suggestions made in this report. Legislative action should be taken, if necessary.

Every effort should be made to further increase and expand the two-way exchange of staff between industry and teaching establishments including the introduction of systems of recognition and incentives. (4.14 and 4.3)

5.32 Industrial establishments should examine how to strengthen their access directly and indirectly to teaching/research institutions with a view to make better use of the consultancy and research services offered by the teaching/research institutions. Higher technological institutions and industrial establishments should prepare corporate plans for working together for social development and mutual benefit. The tendency on the part of the industry to look at the West for technical know-how should be discouraged. It is recommended that a tax be levied on any know-how imported. (3,5, 4,10, 4.3 and 4,14).

5.33 A 'research cess' should be levied on each industry for research in the areas of industry's interest. This fund should be kept and operated separately with the active participation and involvement of industry. Regular long term post-graduate programmes suggested by industry jointly or otherwise should be financed by industry at least on a 50% basis. Short-term courses suggested by industry should be financed by them on a 100% basis. A 133% tax deduction should be allowed on all payments/contributions/investments made by industry in post-graduate education and research. Polite persuation and concealed compulsion are called for to legitimise industry's involvement in post-graduate education and research. (4.14)

Research, socio-economy relevance :

5.34 Post-graduate programmes can survive only on a strong R & D base. Unfortunately a good amount of research work going on in the country is without review and accountability. Most of the work is done under western perspectives and on borrowed ideas and relate to fashion-oriented problems which are totally out of Indian context. There is urgent need to take deliberate action to prevent enormous wastage of resources on repetitive and irrelevant research projects. Academic research should emphasise work done in the context of socio-economic development. (4.10.1 - 4.10.3, 4.3.2 and 4.3.3)

5.35 Some institutions have done well in undertaking sponsored research projects and consultancy projects. This culture should be developed without detriment of-course to the academic and training duties/commitments of the institution: (4.10.3)

5.36 The institutions should be allowed to charge sponsored research projects. Consultancy should be encouraged and should, as far as possible be only institutional; but individual consultancy especially when institutional facilities are not used should also be allowed. In either case, consultancy

should be regulated on the basis of predetermined norms. The money earned from sponsored and consultancy projects should be utilised for developing the research capability of the institutions. Industrial consultancy should not be confused with routine testing and analysis, which should be discouraged. (4.10.4 and 4.14.3)

5.37 Multi-disciplinary, trans-disciplinary transorganisational research with emphasis on design and development should be encouraged at all levels. The postgraduate projects should, as far as possible, be sponsored and/or techno-economic oriented. Problems of industry should be documented and distributed to post-graduate institutions on a continuing basis. It is recommended that a national level R & D Newsletter (like the Employment News) should be published regularly giving information on research projects at master's doctoral and post-graduate institutions, R & D organisations and industry. It is recommended that all-India conferences on post-graduate projects may be organised once in two years and these projects documented area/discipline-wise. (4.10.5, 4.10.6, 4.4 and 4.14.3)

5.38 These institutions which have the competence to undertake on a large scale research projects sponsored by outside agencies should be permitted to recruit and maintain a core of competent scientific staff in the area of their expertise on permanent basis with all service benefits. The expenditure in this regard should of-course be a charge on the cost of the various projects and should be collected from the sponsoring agencies including Government departments. (4.10.4, 4.11.1. and 4.11.2)

Funding pattern, elimination of imbalances :

5.39 One of the main reasons for the degeneration of post-graduate programmes in engineering and technology in India has been the poor norms of funding these programmes.

Consequently post-graduate activities have remained under-nourished and ineffective in most of the institutions. The courses have remained simple academic exercises unable to generate adequate R & D activities, which are absolutely necessary to train competent engineers in areas of design, development and innovations.

Immediate action should be taken to revise the norms of funding the post-graduate programmes on the basis of the guidelines suggested in this report. (3.8, 4.12.1, 4.12.2, 4.12.4 and 4.12.5)

5.40 Recommendation of grants for any new post-graduate programme should be based on the overall post-graduate activities of the departments concerned and not on a narrow truncated basis of specific post-graduate course/courses propsed by an institution. (4.12.6)

5.41 While it is necessary to undertake in a phased manner the need-based consolidation of all institutions (running approved post-graduate programmes) including modernisation of laboratories and replacement of obsolete equipment, it is strongly recommended that such need-based consolidation be undertaken on a priority basis in selected institutions/departments, which, despite poor funding, have proved their merit by their past performance. These institutions/departments should be subject to close scrutiny by competent Visiting Committees with a view not only to consolidate, but also to identify expertise they have by now achieved in emerging areas of national relevance and to promote them as Centres of Excellence/Advanced Studies. They should serve as nuclei for technological development in their respective regions. A provision of about Rs. 20 crores may have to be made for the purpose during the Sixth Five Year Plan (1980–85). (4.12.7)

5.42 The disparities in the pattern of funding post-graduate programmes have created lots of problems particularly in the university departments under the control of the UGC. The portion of post-graduate grants released to the university departments of State Universities through the UGC (with the complicated condition that the concerned State Governments should take over the responsibility of funding after 5 years) is a small fraction of the total expenditure incurred by the Central Government on post-graduate education and research in engineering and technology. It is recommended that funding post-graduate education and research in engineering and technology in all engineering institutions including university departments should be a 100% Central Government responsibility and the existing dichotomies / disparities in funding should be eliminated. (4.13.1—4.13.6)

5.43 In the case of institutions of national importance, which are to be maintained and further developed as pace-setters, funding should be based on integrated infra-structural development as at present. However, even in these cases, assistance to the various departments should be performance-based. (4.13.7)

5.44 Since non-Plan provisions have been approved with effect from 1979-80 for meeting the recurring liability in respect of the on-going post-graduate programmes, the Central Government should advise State Governments to extend retirement and other service benefits to post-graduate staff in

institutions which are governed by the State Government grant-in-aid rules. (4.12.5)

Information services, data banks:

5.45 One of the biggest stumbling blocks in the path of scientific and technological research and development in India has been - and is - the lack of proper data banks/information services. There is immediate need to educate and train information users by introducing user education/training programmes in the post-graduate institutions snd research centres. A suitable national agency should undertake this responsibility in collaboration with INSDOC, NISSAT, *etc.* (4.19.1—4.19.3)

5.46 India has started importing bibliographic data bases alongwith the appropriate software to develop a computerised information retrieval system in the country. It is not only necessary for India to absorb this imported 'information technology', but also to develop her own to suit local needs. (4.19.4 and 4.19.5)

5.47 One very important approach to information is computerised information retrieval. It is recommended that there should be a couple of National Data Centres in India which should get all the major data bases of science and technology in the form of computer readable magnetic tapes and act as data banks. (4.19.6 and 4.19.7)

Administration and control, evaluation and accreditation:

5.48 The main factor which has been primarily responsible for almost all the ills of post-graduate education and research in engineering and technology in India today has been the failures of the administration-the AICTE/Post-graduate Board - to implement the recommendations not only of the Committees appointed by it, but also of its own. This Committee's most important single recommendation linked to very many other proposals in various sections of this report is that the Government should make the AICTE/Post-graduate Board a new statutory organisation—a National Authority—with powers granted to it by Parliament to advance and promote the technological development of this country by maintaining high standards of engineering and technological education and research. This is only a reiteration of the recommendation made two years ago by the Estimates Committee of Parliament. (4.18.4, 4.18.5 and 4.20.2).

5.49 It is essential to optimise the utilisation of available resources and provide impetus to all the centres engaged in post-graduate programmes and research. The planning, organisation and prescription of standards for post-graduate education and research programmes conducted at universities, IITs, Indian Institutes of Management and affiliated colleges should be effectively coordinated by the proposed National Authority, which should have a separate full-time secretariat with suitable administrative, executive and financial powers. (2.4 2, 4.18.5 and 4.20.2).

5.50 Evaluation and accreditation of post-graduate courses should be done at least once in five years. For this purpose, a National Evaluation and Accreditation Agency should be established. (4.18.6 and 4.18.7).

5.51 Methods should be developed for the performance audit of institutions engaged in post-graduate education and research to facilitate comprehensive reviews of the various programmes. The general practice of financial expenditure audit should be done away with. (4.18.8).

TCDC, policy for training overseas students:

5.52 India has a leading role to play in the new concept of TCDC. In her own interest, India should formulate a coherent 'country training policy' for training overseas students in emerging areas of engineering and technology. (4.22.1 and 4.22.2).


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ANNEXURES

(*Note :* Data given in Annexures III to X are approximate. Only institutions which have furnished data and only data which have been furnished by institutions have been mentioned in these Annexures.)

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ANNEXURE I

QUESTIONNAIRE USED FOR THE REVIEW OF POST-GRADUATE EDUCATION & RESEARCH IN ENGINEERING AND TECHNOLOGY

(Note : Data to be given in duplicate separately for each department)

1. **Name and address of the institution :**

2. **Name of the department :**

3. **Details of full-time and part-time courses offered** (during the past five years)

Subject & year of starting	Sanctioned intake	Actual intake	Out-turn	Reasons for drop-outs.

4. **Entry qualifications for :**

Master's Degree Doctorate Degree P. G. Diploma

5. **Course requirements for :**

Master's Degree Doctorate Degree P. G. Diploma

6. **Educational improvements :** (during the past five years) :

   a) Contribution to curriculum development :

   b) Innovation in laboratory experiments :

   c) New electives/topics introduced :

   d) Notable aspects of instructional methods :

7. **Research and development (R & D) activities** (during the past five years) :

   a) M.Tech projects :

   b) Doctorate projects :

   c) P.G. Diploma projects :

   d) Sponsored projects :
   (Indicate name of sponsor)

8. **Industrial liaison and consultancy**
(during the past five yesrs) :

a) **Consultancy projects :**

Sl. No.	Project title	Sponsor and financial support	Faculty/Students

b) **Patents :**

Sl No.	Title	Granted/Applied for	Faculty/Students

c) **Testing and calibration :**
Number of jobs completed.

d) **Technology transfer** :

Sl. No.	Item	Industry	Faculty/Students

9. **Publication (during the past five years) :**
(Review papers and un-published conference papers) to be given separately :

Sl. No.	Title	Author	Journal (Vol. No. & Pages)

10. **Details of continuing education programmes :**
(organised during the past five years)

Sl. No.	Title	Dates	Participation

11. **Details of conferences and seminars organised (during the past five years) :**

Sl. No.	Title	Dates	Participation

12. **Physical facilities** :

a) **Buildings** :

Area sanctioned	Actually provided	Addl. requirements, if any.

b) **Faculty :**

Sanctioned (*Category-wise*)	*In position* (*Year-wise*)	*Remarks, If any*

(Please give separately a complete list of faculty indicating their age qualifications, experience, etc.).

c) **Major equipment** :

Available *Yet to be procured*

d) **Library facilities** :

Area :

No. of books/volumes :

Journals subscribed for : Indian/Foreign

Facilities for Xeroxing/micro-filming :

Level of utilisation of library :

13. **Funding pattern (during the past five years)** :

Sources and details of income.

14. **Utilisation of funds** :

a) **Recurring expenditure (during the past five years)** :

Ceiling approved *Actual expenditure year-wise on* :

Salary

Scholarships

Consumables

Others

b) **Non:recurring expenditure** (during the past five years) :
Give item-wise.

c) **Methodology of utilisation of funds** :

15. **Information on placement and employment pattern of your post-graduates, if available** :

16. **Your self-assessment of department's capabilities for post-graduate programme with suggestions, if any, for improvement** :

17. **Any other relevant information** :


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ANNEXURE II

REFERENCES

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ANNEXURE III

DETAILS OF POST-GRADUATE INTAKE AND OUT-TURN

IITs

1. Bombay

Field/Subjects	(Average for 1975-76 to 1977-78) Sanctioned intake	Actual intake	Out-turn
	1	2	3
M. Tech.			
Aeronautical Engg.		14	7
Chemical Engg.		38	16
Civil Engg.		38	22
Electrical Engg.		54	43
Mechanical Engg.		47	34
Metallurgical Engg.		27	18
Industrial Engg. & Operations Research		8	4
Material Science		11	5
Environmental Sc. & Engg.		7	continuing
Systems & Controls		7	do
Computer Science		27	do
		278	149
D.I.I.T.			
Applied Hydraulics		7	5
Dock & Harbour Engg.		4	7
Industrial Design		8	7
Computer Science		11	7
Aerial Photo Interpretation		7	6
Foundry Technology		5	2
		42	34

2. Kanpur

	1	2	3
Aero Engg.		15	11
Chemical Engg.		25	20
Civil Engg.		46	18
Electrical Engg.		43	31
Mechanical Engg.		34	16
Metallurgical Engg.	38	24	15
Computer Science	45	14	8
Material Science	15	10	5
Industrial & Management Engg.	20	7	5
Nuclear Engg. & Technology	13	10	5
		228	134

3. Kharagpur

M.Tech.

Agricultural Engg.	52	46	32
Aero-Engg.		5	4
Chemical Engg,		28	16
Civil Engg.		19	16
Electrical Engg.		28	13
Electronics & Comm. Engg.		32	21
Mechanical Engg.		63	34
Industrial Engg. & Operations Research		21	18
Industrial Management		16	12
Metallurgical Engg.		17	8
Architecture		40	19
		308	193

D.I.I.T.			1	2	3
Agriculture Engg.			13		6
Applied Geology			9		1
Naval Architecture	12		16		14
Applied Chemistry			7		5
Applied Mathematics			14		11
Industrial Physics	6		3		—
			62		37

4. MADRAS		M.S.	M.Tech.	M.S.	M.Tech
Aeronautical Engg.	12	4	11	1	5
Chemical Engg.		8	25	3	18
Civil Engg.		6	27	1	15
Electrical Engg.		11	43	2	27
Industrial Engg.		2	14	1	14
Industrial Management		5	12	3	16
Mechanical Engg.		13	57	3	42
Metallurgical Engg.	25	3	20	3	14
Computer Science	5	5	22	—	15
Applied Mechanics	17	4	9	3	1
		61	240	20	167

D.I.I.T.			
Applied Mechanics	3		2
Civil Engineering	—		3
Mechanical Engineering	15		11
	18		16

5. DELHI	Sanctioned intake	Actual intake	Outturn
M.Tech.			
Applied Mechanics	15	19	6
Chemical Engg.	20	25	7
Civil Engg.	30	46	22
Electrical Engg.	50	74	43
Mechanical Engg.	40	53	22
Textile Engg.	20	21	18
Systems & Management studies	15	19	5
Applied Chemistry (Modern Methods in Chem. Analysis)	20	15	6
Applied Physics (Optics, Solid State Physics)	20	22	17
	230	294	146
D.I.I T.			
Chemical Engg.		—	4
Electrical Engg.		—	1
Applied Physics		—	1
Civil Engg.		—	—
Mechanical Engg.		—	3
Mathematics (Numerical Methods & Auto Computing)	10	10	8
	10	10	17
6. II Sc. BANGALORE M.Tech.			
Applied Physics		13	10
Electrical Comm. Engg.		21	19
Electrical Engg.		22	20
High Voltage Engg.		7	—

Automation	23	16
Mechanical Engg.	50	42
Metallurgical Engg.	13	5
Civil Engg.	34	18
Chemical Engg.	20	11
Aeronautical Engg.	30	28
	233	169

DIPLOMA

Electrical Communication	13	9
Industrial Management	11	10
High Voltage Engg.	14	11
Bio-Physics	5	5
	43	35

ABSTRACT IN RESPECT OF IITs & IISc

(Average 75-76 to 77-78)

	Actual Intake		Out-turn		
	P.G. Degree	Diploma	P.G. Degree	Diplo-ma	Ph.D.
IIT Bombay	278	42	149	34	41
IIT Delhi	294	10	146	17	41
IIT Kanpur	228	—	134	—	40
IIT Kharagpur	308	62	193	37	29
IIT Madras	301	18	187	16	44
IISc Bangalore	233	43	169	35	50
	1642	175	978	139	245

UNIVERSITY DEPARTMENTS

(Average of three years 1975-76 to 1977-78)

	Sanctioned Intake	Actual Intake	Out-turn
1. Department of Chemical Technology, Bombay University. Maharashtra			
M.Tech.	1	2	3
Textile Chemistry Food & Fermentation Tech. Organic Tech. High Polymers including Plastics Pigments, paints Varnishes & Rubber Tech. Oils, Fats and Waxes M.Chem. Engg. Pharmacy	54	50 — 8	27 8 5
		58	40+5 changed over to Ph.D.
2. M.S. University, Baroda, Gujarat			
M.Tech.			
Civil			
Soil Mechanics & Foundations Engg. (Geo. Tech. Engg.)	8	3	2
Highway Engg.	8	2	1
Hydraulic Structure	8	2	1
Public Health	8	6	4
Structural Engg.	8	3	4
Architecture (Low cost housing)	10	4	started in 1979
Water Resources Engg.	8	—	—

Mechanical	1	2	3
*Production Engg.	1	6	3
Heat Power Engg.	10	6	3
Refrigeration & Air-Conditioning (P.G. Dip.)	10	5	1
Electrical			
Control Systems	10	7	1
Power Systems	5	3	2
*Chemical Engg.	10	3	started in '79
Textile Engg.	10	4	3
*Pharmacy (M.Pharm)	10	3	started in '79
*Metallurgy	10		
	143	57	25

3. **a) Laxminarayan Institute of Technology, Nagpur University, Maharashtra**

Chemical Engineering and Chemical Technology			
4 Specialisations (M.Tech.)	15	15	12

b) Department of Pharmacy, Nagpur University

(M.Pharmacy)			
M.Pharm. Pharmaceutics	20	22	21
M.Pharm. in Pharmaceutical Chemistry with specialities in pharmacognosy.			
*Clinical Pharmacy			

4. Saugar University, Sagar, Madhya Pradesh

Pharmacy (M.Pharm.)	29	20	19
Pharmaceutics			
Pharmaceutical Chemistry			

5. Calcutta University, Calcutta, West Bengal

Department of Radio Physics & Electronics	80	25	20
Applied Physics		10	5
Applied Chemistry			
Plastic and Rubber			

6. Jadavpur University, Calcutta, West Bengal. (M.Tech.)

Civil			
Structural Engg.	20	17	3
Soil Mech. & Foundation Engg.			
Public Health Engg.			
Water Resources Engg.			
Mechanical Engg.	20	19	8
Production Engg.			
Heat Power			
Machine Design			
Turbo Machinery			
Electrical	20	20	5
Power System			
Control System			

Tele-Communication Engg.	20	20	8
Control Engg.			
Computer Engg.			
Electro Devices & Micro-wave Engg.			
Chemical Engineering	20	20	1
Energy & Mass Transfer Operations.			
Process Engg. & Combustion Engg.			
Food & Bio-Chem. Engg:	6	6	Nil
Cereal Technology, Protein			
Tech. & Fermentation Tech.			
Pharmacy. (M. Pharm.)	20	17	14
Pharmaceutical Chemistry			
Pharmaceutics			
Pharmacology			
Microbiology & Bio-Chemistry			
Industrial Metallurgy			
(M. Tech.)	—	—	—
	— —	— —	— —
	126	121	39

7. **Burla Engg. College, Sambalpur University, Orissa.**

Civil (M.Tech.)	5	—	—
Irrigation			

	1	2	3
Electrical	5	—	—
Power System			
Mechanical	2	—	—
Machine Design			
8. Punjab University, Chandigarh (M.Tech.)			
Chemical Engineering	15	—	—
Pharmacy (M. Pharm.)	15	—	—
9. Aligarh Muslim University, Aligarh			
Civil	16	28	4
Hydraulic Structures			
Building Engineering			
Electrical	25	27	5
Instrumentation & Control			
System Engg.			
Mechanical	21	21	7
Thermal Engg.			
Industrial Engg.			
Machine Design			
Tubro-Machinery			
	62	76	16
10. Allahabad University, Allahabad. Uttar Pradesh			
Electronics Engg.	10	—	—

	1	2	3
11. Roorkee University, Roorkee, Uttar Pradesh (M.Tech.)			
Civil Engg.	70		
Structural Engg.		9	2
Highway Engg.		12	6
Hydraulic Engg.		14	6
Soil Mechanics & Foundation Engg. (Geo. Tech. Engg.)		13	9
Public Health Engg. (Environmental Engg.)		7	3
Advanced Survey and Photography		10	9
Hydrology (Diploma)	30	34	34
Water Resources Development (Diploma)	50	42	41
Earthquake Engg.	10	10	4
Bldg. Sc. (Diploma) } only for sponsored candidates		8	6
Earthquake Engg. (Diploma) } only for sponsored candidates			
Electrical Engg.	30		
Power Systems		8	4
Advanced Elec. Machines			
Measurement & instrumentation		13	8
System Engg., Operations Research		7	6
Power Apparatus & Elect. Devices		10	4

	1	2	3
Electronics & Comm. Engg.	20		
Microwave Engg. & Radar Communication System Control & Guidance Solid State Electronic Devices		20	10
Television Tech. (Diploma)	30	9	5
Computer Sc. & Tech. (Diploma)		10	5
Mechanical Engg.	30		
Production Engg.		18	5
Machine Design		6	3
Applied Thermo Science		9	4
Chemical.	15		
Plant Design		14	8
Metallurgical Engg.	15		
Physical Metallurgy		5	5
Extraction Metallurgy			
Powder Metallurgy (Diploma)		2	1
Architecture (M.Tech.)	10	4	6
Urban & Regional Planning		6	4
	310	300	198

	1	2	3
12. Birla Institute of Technology and Science, Pilani, Rajasthan			
Civil	20		
2 Specialisations			
Electrical & Electronics	30		
3 Specialisations		2	15
Mechanical Engineering	20		
2 Specialisations			2
Chemical			
Computer Science (M.Sc. Tech.)	15	2	6
Instrumentation ,,	10	5	7
Museum Studies ,,	10		
Sc. & Tech. Development ,,	10	1	1
Pharmacy (M.Pharm.)	10	2	4
2 Specialisations			
	125	12	35
13. Banaras Hindu University Varnasi, Uttar Pradesh			
Chemical	25	18	13
Petroleum Refinery Engg.			
Oil, Fats, etc.			
Civil	20	20	8
Hydraulics			
Structural Engg.			
Soil & Foundation Engg.			
•Environmental Engg.			

	1	2	3
Electrical	20	20	4
Control/power System Engg.			
Electrical Machine Drives			
Metallurgy	25	25	13
Ferrous/non-Ferrous Metallurgy.			
Physical/Foundry Metallurgy			
Mechanical	25	25	9
Machine Design			
Heat Power			
*Production Engg.			
Mining	10	1	1
Coal/Metal Mining.			
Pharmaceutical (M. Pharm.)	15	12	10
Pharmacognosy, Pharmaceutics and Pharmacology,			
Pharmaceutical Chem.			
Silicate Technology (Ceramic Engg.)	10	10	3
**Electronics.*	10	12	5
Microwave Engg.			
Electronic Instrumentation			
Micro Electronics.			
	160	143	66

	1	2	3
14. G.B. Pant University of Agriculture and Technology, Pantnagar, Uttar Pradesh.			
Civil	15		
Structural Engg.		9	5
* Mechanical Engg.	3	3	3
	18	12	8

15. M.B.M. Engineering College, Jodhpur University, Rajasthan.

		F.T.	*P.T.*	*F.T.*	*P.T.*
Civil					
Structural Engg.	5	2	4	1	1
Soil Engg.	6	—	1	—	
Environment Engg. / Desert Technology	10		3		—
Desert Technology (Diploma)	5		3		1
Electrical					
Control System	6		7		2
Mechanical					
Heat Power Engg.	6		5		2
Prod. & I. E.	6		4		3
Mining					
	38		26		9

16. College of Engg. Tirupati,
Sri Venkateswara University, Andhra Pradesh.

Civil			
Hydraulics (Water Resources Engg.)	—	1	1

	1	2	3
Electrical			
Instrumentation & Control system **Electronics instrumentation & Control System	30	10	6
Mechanical			
Industrial Engg.		10	—
		—	—
		21	7
		—	—

17. **Andhra University, Waltair, Andhra Pradesh.**

Civil Engg.	20		
Structures		9	3
Hydraulics		1	5
Public Health		8	2
Soil Mechanics & Foundation Engg.	—	4	continuing
Mechanical Engg.	30		
Machine Design		14	—
Industrial Engg.		10	continuing
*Marine Engg.		6	—
Industrial Engg.	10	10	—
Electrical Engg.	30		
Power System		10	7
Control System		10	6
*Computer Engg.		10	Continuing
Chemical Engg.	20	20	7
Chemical Technology	20	20	—
*Mineral Process Engg.	10	10	—

	1	2	3
Pharmacy (M. Pharm.)	25		
Pharmaceutical & Food Analysis, Pharmaceutical Chemistry, Pharmaceutical Chemistry, Fermentation Tech., *Pharmacology		52	15
	165	167	45

18. Osmania University, Hyderabad, Andhra Pradesh

Civil Hydraulics, Structures, Solid Mechanics & Foundation Engg.			
Electronics & Comm. Engg. Control Engg., Electronic Devices & Circuits, Microwave Engg.	44	36	20
Electrical: Power System, Electrical Machines			
Mechanical Engineering Production Engg.			

	1	2	3
Chemical Engineering			
Transfer Process			
Plant Design			
Process Dynamics & Control	26	16	12
Chemical Technology			
Oil & Ceramics Technology			
	70	52	32

19. **Visveswarayya College of Engineering, Bangalore University, Karnataka.**

Civil			
Structures		10	5
Soil Mechanics and Foundation Engg.		6	2
Public Health Engg. (Environmental Engg.)	40	6	3
*Highway & Airport Engg.		6	2
*Material Science of Control Tech.		5	2
*Prestressed Concrete Tech.		6	3
Mechanical			
Machine Design		10	5
*Metal Casting Science & Engg.		5	2
Electrical			
Power Systems		10	5
	40	64	29

	1	2	3
20. Annamalai University, Annamalainagar, Tamilnadu.			
Civil			
Structures			
Soil Mechanics &			
Foundation Engg.			
Mechanical			
Heat Power			
Electrical			
Power Systems	50	12	2
Chemical Engineering			
Chemical Engg.		13	9
	50	25	11
21. J. N. Tech. University, Hyderabad			
i.) Engineering College, Ananiapur			
Civil			
Structures	10	1	–
Electrical			
Power Systems	10	4	1
Mechanical			
Heat Power (Refrigeration & Air-Conditioning)	10	5	5
	30	10	6

	1	2	3
ii) College of Engineering, Kakinada.			
Civil			
Soil Mech. & Foundation Engg.	8	1	1
Electrical			
Power Systems	8	5	2
Mechanical			
Machine Design with emphasis on foreign equipment & Machinery	7	6	3
Electronics			
Instrumentation & Control System	7	9	5
	30	21	11

22. **P. A. University of Technology, Madras**

i) College of Engineering, Guindy			
Civil			
Structural Engg.	10	10	6
Hydraulics	6	6	1
Soil Mechanic & Foundation Engg.	6	6	4
Public Health Eng.	10	10	2
Urban Engg.	10	10	4
Mechanical			
Heat Power (I. C. Engg.)			
Ref. & Air-Cond. Engg.	12	12	12
Production Engg.	10	9	8
Engineering Design	6	5	1

	1	2	3
Electrical			
Power System	10	10	5
High Voltage Engg.	10	5	5
Electronics			
Communication Engg.	6	6	4
Applied Electronics	10	10	8
*O. R. (Diploma)	10	5	5
Traffic Engg. (Diploma)	10	10	2
Industrial Engg. (Diploma)	6	10	5
	132	124	72

ii) *Madras Institute of Technology, Chromepet.*

Aeronautical Engg.			
Air-craft Structural Mechanics	10	10	3
Electronic Engg.			
Applied Electronics	10	10	9
	20	20	12

iii) *A. C. College of Technology, Guindy.*

Chemical Engineering	20	10	9
Textile Technology	10	10	6
iv) *School of Architecture & Planning*			
Town & Country Planning	20	16	8

1	2	3
23. Ravishankar University, Raipur, Madhya Pradesh		
*Applied Geology	10	10	continuing
24. Cochin University, Cochin, Kerala		
Part-time courses in Production Engg., Machine Design, Power Systems Industrial Electronics, Project Engg., Building Technology & Construction Management.	113	113	

ABSTRACT

UNIVERSITY INSTITUTIONS

	1	2	3
1. Deptt. of Chem. Technology University of Bombay.	54	58	45
2. M.S. University, Baroda.	143	57	25
3. Lakshminarayan Institute of Technology, Nagpur University.	15	15	12
4. Deptt. of Pharmacy, Nagpur University.	20	22	21
5. Saugar University.	20	20	19
6. Calcutta University	80	35	25
7. Jadavpur University	126	121	39
8. Burla Engg. College, Sambalpur University,	12	–	–

		1	2	3
9.	Punjab University	30	—	—
10.	Aligarh Muslim University.	62	76	16
11.	Roorkee University.	310	300	198
12.	Birla Instt. of Tech. & Sc., Pilani	125	12	35
13.	Banaras Hindu University	160	143	66
14.	G.B. Pant University of Agri. & Tech.	18	12	8
15.	M.B.M. Engg. College, Jodhpur University	38	26	9
16.	College of Engg., Tirupati, Sri Venkateswara University	30	21	7
17.	Andhra University	165	167	45
18.	Osmania University	70	52	32
19.	Visveswaraya College of Engg., Bangalore University	40	64	29
20.	Annamalai University	50	25	11
21.	J.N. Tech. University, Hyderabad	60	31	17
22.	P.A. University of Technology, Madras	202	180	107
@23.	Ravishankar University, Raipur	10	10	continuing
@24.	Cochin University	113.	113	continuing
@25.	Punjab Agriculture University, Ludhiana.	Course recently started		
@26.	Jiwaji University, Gwalior, M.P.			
		1953	1560	766

Note : The Universities at Sl. No. 25 and 26 have not been included in the text of the Report.

@These courses do not have the approval of the Post-graduate Board.

REGIONAL ENGINEERING COLLEGES

(Average of three years 1975-76, 1976-77 & 1977-78)

	Sanctioned intake	Actual intake	out turn
	1	2	3
Suratkal			
1. Marine Structures	10	6	5
2. Hydraulics & Water Resources Engg.	5	3	1
3. Process Metallurgy	5	4	3
4. Industrial Structures	10	3	2
5. Chemical Plant Design	5	5	4
6. Industrial Electronics	10	10	9
7. Heat Power Engg.	5	5	5
	50	36	29
Kurukshetra			
1. Design of Machines	8	4	3
2. Soil Mechanics & Foundation Engg.	8	8	4
3. Structural Engg.	8	6	2
4. Elec. Control Systems	8	8	8
5. Power Systems	8	8	8
6. Scientific Instrumentation (Diploma)	5	4	2
	45	38	27

	1	2	3
Warangal			
1. Transportation Engg.	10	4	4
2. Hydraulics & Water Resources Engg.	10	6	3
3. Electronics Instrumentation	10	11	5
4. Design & Production Engg. Machine Tools	10	10	5
5. Chemical Plant Engg.	10	9	8
6. Applied Soil Engg. (Geo. Tech.)	10	5	4
7. Engineering Structures	10	8	8
8. Power System Engg.	10	8	8
9. Elec. Machines & Instrumentation Devices	10	8	4
10. Design & Production of I.C. engines & Gas Turbines	10	9	4
11. Engg. Physics	10	6	6
12. Applied Maths.	10	3	7
	120	87	66
Tiruchirapalli			
@1. Industrial Metallurgy	5	2	2
@2. Welding Engg.	5	5	4
3. Civil Engg.	10	NA	NA
4. Electrical Engg.	8	3	3
@5. Chemical Engg.	6	7	7

	1	2	3
6. Electronics & Communication Engg. (Full & Pt.)	6	2	2
@7. Design & Production of Thermal Plant Equipment	8	8	8
@8. Industrial Engg. (Diploma)	6	2	2
@9. Applied Maths (M.Sc.)	10	6	3
@10. Applied Electronics (M.Sc.)	12	8	continuing
	76	43	31

Nagpur

1. Integrated Power Systems	10	10	7
@2. Heat Power	5	5	4
@3. Production Engg.	5	5	1
@4. Process Metallurgy	5	1	1
5. Public Health Engg	10	5	3
@6. Structural Engg. (Pt.)	5	7	2
@7. Communication Engg. (Pt.)	5	5	2
8. Ferrous Alloys (Diploma)	10	2	—
9. Hydraulics (Pt.)	5	5	1
	60	45	21

Jaipur

@1. Water Resources Engg. (Pt.)	5	2	1
@2. Elec. Power Systems	10	10	continuing
3. Non-Ferrous Metallurgy	8 9		-do-

		1	2	3
4.	Irrigation Hydrology (Diploma)	8	7	6
@5.	Structural Engg. (Pt.)	10	3	continuing
@6.	Mechanical (Pt.)	10	4	1
		51	35	8

Jamshedpur

1.	Elec. Power Systems	5	6	1
2.	Extractive Metallurgy	20	17	3
3.	Foundry Tech.	20	–	–
		45	23	4

Durgapur

@1.	Chemical Engg. (Pt. & Full)	10	11	3
2.	Structural	5	5	1
@3.	Elec. Systems	10	8	4
4.	Metallurgy (Forging, Rolling & Heat Treatment)	10	8	4
5.	Extractive Metallurgy	10	10	3
		45	42	15

Surat

1.	Environmental Engg.	5	4	3
@2.	Transportation Engg. & Planning	5	1	1
@3.	Mechanical Engg.	12	6	1
@4.	Power System Engg.	10	2	continuing

	1	2	3
@5. Soil Mech. & Foundry Engg.	5	1	1
@6. Structural Engg.	5	3	1
	42	17	7

Allahabad

1. Analysis & Design of Process Equipment.	10	10	5
2. Structural (Full & Pt.)	10	10	4
3. Soil Mech. & Foundation Engg. (Full & Pt.)	10	3	Continuing
@4. Environmental Engg. (Pt.)	10	20	5
5. Electrical (Full & Pt.)	20	10	8
6. Design of Process Machines	10	10	4
7. Production of Process Machine (Full & Pt.)	10	12	7
	80	75	33

Bhopal

@1. Engg. Materials	10	16	10
2 & 3. Design & Production of Power Plant Machines.	10	7	2
(Hydro, Elect. & Thermal.)	10	5	4
4. Foundation Engg.	10	13	3
@5. Mechanical Engg.	10	7	3
	50	48	22

Rourkela		1	2	3
1.	Communication Engg.	5	5	8
@2.	Design & Production & Heavy Machines.	10	10	5
@3.	Tech. of Met. Furnace	10	8	3
4.	Structural	5	5	1
5.	Soil Mechanics	5	5	1
@6.	Power System & Control (Pt.)	15	15	Continuing
@7.	Ferrous Process Met. (Pt.)	20	13	-do-
@8.	Machine Design & Elements (Pt)	15	15	-do-
		85	76	13
Calicut				
1.	Heat Power	10	8	5
2.	Instrument & Control	10	5	Continuing
3.	Structural	10	3	1
		30	16	6

@These are courses not approved by the P.G. Board

ABSTRACT IN RESPECT OF RECS

1.	Surathkal	50	36	29
2.	Kurukshetra	45	28	27
3.	Warangal	120	87	66
4.	Tiruchirapalli	76	43	31
5.	Nagpur	60	45	21
6.	Jaipur	51	35	8

		1	2	3
7.	Jamshedpur	45	23	4
8.	Durgapur	45	42	15
9.	Surat	42	17	7
10.	Allahabad	80	75	33
11.	Bhopal	50	48	22
12.	Rourkela	85	76	13
13.	Calicut	30	16	6
		779	581	282

STATE GOVERNMENT COLLEGES

1. Govt. Engg. College, Poona, Maharashtra

Civil :

Structural	4	9	7
Construction Management	4		
Soil Mechanics	4	3	

Mechanical :

Heat Powers	4	5	4
Machine Design	4	6	

Electrical :

Power Systems	4	6	2
Control Systems	4	2	

	1	2	3
Electronics & Tele. Communication :			
Microwaves	4	4	5
Instrumentation & Controls	4	9	
Metallurgy :	4	3	2
Town Planning	20	10	3
	60	62	23

2. *S. K. S. J. Tech. Institute, Bangalore, Karnataka*

Textile Technology	10	10	3

3. *Govt. College of Pharmacy, Bangalore, Karnataka*

Pharmacology, Pharmacognosy, Pharmaceutical Tech.	30	14	started in 78 only.

4. *Engg. College, Trichur, Kerala*

Production Engg.	6	7	4
Power Systems	6	6	3
Process Control	6	4	3
	18	17	10

5. *College of Engg. Trivandrum, Kerala.*

Structures	6	6	6
Hydraulics	6	2	2
Soil Mechanics	6	2	2
Public Health Engg.	6	2	1
Electrical Machines	6	4	3

	1	2	3
Power System	6	5	5
Control System	6	6	5
Electronics & Comm. Engg.	6	4	NA
	48	31	24

6. *Govt. College of Engg., Coimbatore, Tamil Nadu.*

Structural (Full T)	10	5	4
Structural (Part T)		3	3
Power Systems	10	5	4
Heat Power	10	5	3
Engg. Design	10	4	2
	40	22	16

7. *L.D. College of Engg., Ahmedabad, Gujarat.*

Power Systems	10	8	3
Refrigeration & Airconditioning	5	8	2
Internal Combustion Engines	5	NA	NA
Soil Engg.	6	NA	NA
Public Health Engg.	5	NA	NA
	30	16	5

8. *Govt. Engg. College, Jabalpur, Madhya Pradesh.*

Soil Mechanics & Foundation Engg	7	3	1
Public Health Engg.	7	5	3
Structural	6	5	1
Heat Power	5	5	2

	1	2	3
Machine Design	5	5	Nil
High Voltage	5	3	1
Control System	5	4	1
Microwave	5	6	2
Communication System	5	4	3
	50	40	14

9. Assam Engg. College, Gauhati, Assam.

Water Shed Management & Flood Control. (started in 1977).	10	3	continuing

10. Govt. Engg. & Tech. College, Raipur, Madhya Pradesh

Applied Geology	10	10	6

11. Bihar Institute of Technology, Sindri, Bihar

Mechanical Engg.	10	11	Nil
Electrical Engg.	10	7	1
Metallurgical Engg	5	5	Nil
Chemical Engg.	5	6	Nil
Civil Engg.	6	7	Nil
Instrumentation (Diploma)	5	6	1
	41	42	2

12. Bengal Engg. College, Howrah, West Bengal.

1. Power Systems	10	10	|	5
2. Control Systems	10	10	|	

3.	Structural	1	2	3
4.	Soil Mech & Foundry Engg.			
@5.	Irrigation & Flood Control	25	14	9
6.	Public Health			
@7.	Traffic & Transportation	2	20	20 continuing
8.	Production Engg.	20	20	6
9.	Heat Power			
10.	Physical Metallurgy	10	5	3
11.	Hydraulic Machinery & Systems			
12.	Hydraulics	10	9	1
13.	Solid Mechanics			
14.	Fluid Mechanics			
15.	Electronics & Tele.Communication Engg	10	7	2
16.	Town & Regional Planning	10	8	2
17.	-do- (Diploma)	20	20	10
18.	Dipl. in Traffic & Transports Engg	20	20	14
		165	143	72

13. Punjab Engg. College, Chandigarh.

1.	Highway Engg.	14	14	3
2.	Hydraulics & Irrigation	14	14	2
3.	Structural Engg.	14	16	3
4.	Electrical Power Systems	14	14	3
5.	Rotodynamics	14	16	2
		70	74	13

14. Delhi College of Engg., Delhi.	*1*	*2*	*3*
CIVIL ENGG.	20	17	7
Structural Engg.			
Hydraulics & Flood Control			
Public Health Engg.			
MECHANICAL ENGG.	15	22	4
Thermal Engg.			
or			
Production Engg.			
ELECTRICAL ENGG.	15	19	4
(Full & Pt.)			
Instrumentation & Control or			
Advanced Electronics			
	50	58	15

ABSTRACT IN RESPECT OF GOVERNMENT COLLEGES

1.	Poona	60	62	23
2.	S. K. S. J. T. Instt. Bangalore	10	10	3
3.	Pharmacy College, Bangalore	30	14	—
4.	Trichur	18	17	10
5.	Trivandrum	48	31	24
6.	Coimbatore	40	22	16
7.	Ahmedabad	30	16	5
8.	Jabalpur	50	40	14
9.	Gauhati	10	3	—
10.	Raipur	10	10	6

	1	2	3
11. Sindri	41	42	2
12. Howrah	165	143	72
13. Chandigarh	70	74	13
14. Delhi	50	58	15
	632	542	193

NON-GOVERNMENT INSTITUTIONS

1. Tech. Institute of Textiles, Bhiwani, Haryana.			
Textile Technology	5	5	5
2. Thapar College of Engg. & Tech., Patiala, Punjab.			
Structures (Full & Pt.)	10	8	2
	10	5	5
	20	13	7
3. Hbti, Kanpur, Uttar Pradesh			
1. Chemical Engg. Practice	5	—	1
2. Chemical Engg. Design (Full)	5	4	3
(Pt.)	5	—	—
@ 3. Soil Mech. & Foundry Engg.	10	7	6
@ 4. Power Electronics & Controls (Pt.)	10	7	2
@ 5. Mech. Engg. Design (Process Equipment Design (Pt.)	10	11	7
@ 6. Industrial Systems Engg. (Pt.)	10	11	7
7. Bio-chem. Engg.	5	5	4
8. Food Tech.	5	5	4
9. Paints Technology	5	4	3
10. Oil Technology	5	4	4
	75	65	41

	1	2	3
4. VJTI, BOMBAY, MAHARASHTRA.			
1. Public Health Engg.	15	13	8
2. Elect. Engg.	10	8	6
3. Auto. Engg. / 4. Design Engg.	10	12	6
5. Structural Engg.	10	10	8
6. Textiles	10	5	2
7. Elec. Engg. Power Systems & Controls Systems	10	10	8
8. Production Engg.	5	—	—
	70	58	38
5. SHRI GS INSTITUTE OF TECH. & SCIENCE, INDORE, MADHYA PRADESH.			
1. Civil (Structural)	10	16	3
2. Diploma, Highway Engg.	5		
3. ,, Machine Design & Machine Elements	5	4	continuing
@ 4. Industrial & Production Engg. (Pt.)	12	4	NIL
5. Diploma, Elec. Power System	5	12	continuing
6. Electronics & Servo Mechanism	10	11	5
	47	47	8
6. L. M. COLLEGE OF PHARMACY, AHMEDABAD, GUJARAT			
1. Pharmacology	5	5	NA
2. Pharmaceutical & Pharmaceutical Technology	5	4	4

	1	2	3
3. Pharmacognosy	5	3	2
4. Pharmaceutical Chemistry	5	5	4
	20	17	10

7. BIRLA VISWAKARMA MAHAVIDYALAYA, VALLABH VIDYANAGAR, GUJARAT

1. Civil (Structural)	6	5	1
2. Mechanical (Machine Design)	6	3	2
3: Electrical (Power Systems)	6	2	—
	18	10	2

8. PSG COLLEGE OF TECHNOLOGY, COIMBATORE, TAMILNADU

1. Structural Engg. 2. Machine Design. 3. Production Design	10	10	6
4. Machine Tools Engg. 5. Fluid Machinery	38	28	21
6. Industrial Engg. (Diploma) 7. Industrial Design (Diploma)	16	10	3
8. Applied Electronics & Servomechanism 9. Electrical Machines 10. Power Systems 11. Comm. Systems.	40	31	31
12. Textile Technology	10	10	5
13. Computer Science	10	10	continuing
14. Industrial Metallurgy	10	10	continuing
	134	119	66

		1	2	3
9.	*Coimbatore Institute of Technology, Coimbatore, Tamilnadu*			
	1. Civil	6	6	2
	2. Mechanical (Heat Power)	6	3	1
	@3. Diploma, O.R.	6	1	—
	4. Power System	6	5	2
	5. Chemical	6	6	6
		30	21	11
10.	*Thiagarajar College of Engg., Madurai, Tamilnadu*			
	1. Civil	10	10	7
	2. Electrical	10	10	5
		20	20	12
11.	*National Institute of Engineering, Mysore, Karnataka*			
	1. Civil Engineering	8	3	2
	2. Power System	8	5	3
		16	8	5
12.	*Birla Institute of Technology, Ranchi, Bihar*			
	1. Heat Power	6	5	3
	2. Design of Mech. Equipment (Pt.)	25	25	14
	3. Microwave Engg.	6	3	—
	4. Instrumentation & Control	6		

			1	2	3
5.	Control Systems	Pt.	12	24	continuing
6.	Power System		12		
7.	Space Engg. & Rocketry		10	6	continuing
@8.	Rocket & Missile Tech. (Diploma)		6	6	4
			83	69	21

13. *School of Planning, Ahmedabad, Gujarat*

	Town Planning		20	13	9

14. *Walchand College of Engg., Sangli, Maharashtra*

1.	Structural		6	6	
2.	Heat Power		6	6	
3.	Machine Design				10
4.	Power System		6	6	
5.	Control System				
			18	18	10

Abstract in respect of Non-Govt. Institutions

1.	TIT Bhiwani	5	5	5
2.	TCET Patiala	20	13	7
3.	HBTI Kanpur	75	65	41
4.	VJTI Bombay	70	58	38
5.	SGSITS Indore	47	47	8
6.	LMC Pharmacy, Ahmedabad	20	17	10
7.	BVM Vallabh Vidyanagar	18	10	2
8.	PSGCT Coimbatore	134	119	66
9.	CIT Coimbatore	30	21	11
10.	Thiagarajar College of Engg., Madurai	20	20	12

	1	2	3
11. National Instt. of Engg., Mysore	16	8	5
12. BIT Ranchi	83	69	21
13. School of Planning, Ahmedabad	20	13	9
14. Walchand College of Engg., Sangli	18	18	10
	576	481	245

Single Faculty Institutions set up by Central Government :

1. SPA, New Delhi			
Architecture (Urban Design)	10	6	4
Town & Country Planning	20	22	14
Housing & Community Planning	10	5	8
Traffic & Transportation Planning	10	7	6
Land Scape Architecture	15	7	4
	65	45	36
2. NITIE, Bombay			
Industrial Engineering	48	37	35
3. ISM, Dhanbad			
Mining Engg. (Full & Pt.)	6	2	2
Open Cast Mining	12	1	1
Mineral Engg. (M.Tech./Dip.)	10	9	5
Industrial Engg. & Management	20	10	4
Mining Machinery (Pt.)	10	3	—
	58	25	12

Abstract in respect of single Faculty Institutions

1. SPA, New Delhi	65	45	36
2. NITIE, Bombay	48	37	35
3. ISM, Dhanbad	58	25	12
	171	107	83


सत्यमेव जयते

ANNEXURE IV

SOME OF THE POST-GRADUATE COURSES WHICH HAVE NOT BEEN APPROVED BY THE P.G. BOARD

Cochin University

M.Sc. (Engg.). — Chemical, Electrical, Mechanical

BHU-IT

Microwave Engg.
Electronic Instrumentation.
Micro Electronics.

Andhra University

Soil Mechanics & Foundation Engineering.
Computer Engineering.
Electronics & Communication Engineering.
(Instrumentation & Control System).
Heat Transfer Engineering.
Marine Engineering.
Mechanical Handling.
M.Sc. (Mineral Process Engg.).
M.Sc. (Geo-Engg.).
Pharmacology.

Punjab Agricultural University

Elec. Instrumentation System & Control.
Mech. Thermal.
Environmental Engg.

Bengal Engineering College, Howrah

M. Architecture.

SGSITS, Indore

P.G. Diploma in Electrical Power System.
Design of Machine Elements.
Highway Engineering.
Ind. & Production Engineering.

Jiwaji University

(Madhav Instt. of Tech. & Science, Gwalior).
Civil (Structural & Public Health).
Electrical (Electrical Measurements).
Mechanical (Machine Handling).

Government Engineering College, Jabalpur

Mining Engineering.
I.E. & O.R.

Marathwada University

Civil Engineering.
Electrical Engineering.
Mechanical Engineering.

MS University, Baroda

Water Resources Engg.
Production Engineering.
Metallurgical Engineering.
Chemical Engineering.
Pharmacy.
Architecture.

REC, Tiruchirappalli

Industrial Metallurgy.
Welding Engg.
Chemical.
Electronics & Communication Engg. (Full & Pt.).

Design & Production of Thermal Plant Equipment.
Industrial Engg. (Dip.).
Applied Maths. (M.Sc.).
Applied Electronics (M.Sc.).

REC, Nagpur

Heat Power.
Production Engg.
Process Metallurgy.
Structural Engg. (Pt.).
Communication Engg. (Pt.)
Hydraulics (Pt.).

REC, Jaipur

Water Resources Engg. (Pt.).
Elec. Power Systems.
Structural Engg. (Pt.).
Mechanical (Pt.).

REC, Durgapur

Chemical Engg. (Pt. & Full).
Transportation Engg. & Planning.
Elec. Systems.

REC, Surat

Transportation Engg. & Planning.
Mechanical Engg.
Power System Engg.
Soil Mech. & Foundry Engg.
Structural Engg.

REC, Allahabad

Environmental Engg. (Pt.).

REC, Bhopal

Engg. Materials.
Mechanical Engg.

REC, Rourkela

Design, & Production & Heavy Machines
Tech. of Mat. Furnace.
Power System & Control (Pt.).
Ferrous Process Met. (Pt.).
Machine Design & Elements (Pt.).

Cochin University

All Courses.

Jiwaji University

All Courses.

Ravishankar University, Raipur

All Courses.

ANNEXURE V

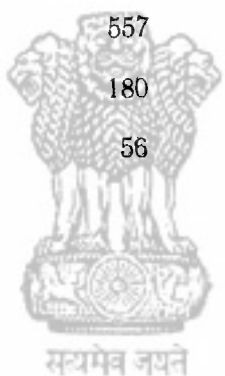
POST-GRADUATES PRODUCED BY VARIOUS INSTITUTIONS TILL 1978

IITs/II Sc.	M.Tech.	P.G. Dip.	Ph.D.	M.Sc.	D.Sc.
1. Delhi	1215	210	144	27	
2. Kanpur	1437	—	217	—	—
3. Madras	1694	186	242	138	—
4. Bombay	2050	355	222	—	2
5. Kharagpur	3106	373	397	165	2
6. II Sc. Bangalore	2859	434	458	—	—
	12361	1558	1680	330	4
RECs					
1. Warangal	534	—	34		
2. Bhopal	260	—	—		
3. Jaipur	29	10	—		
4. Rourkela	52	—	9		
5. Calicut	48	—	—		
6. Durgapur	243	—	18		
7. Nagpur	135	27	1		
8. Kurukshetra	58	26	8		
9. Tiruchirappalli	103	—	4		
10. Suratkal	253	—	—		
11. Surat	35	—	—		
12. Allahabad	295	—	6		
	2045	63	80		

	M.Tech.	P.G. Dip.	Ph.D.	M.Phil.
University Institutions				
1. JN Tech. University				
(i) Kakinada College	64	—	—	—
(ii) Anantapur College	35	—	1	—
2. Nagpur University, LN College of Tech.	134	—	—	—
3. J.N. University, New Delhi	—	—	—	10
4. Calcutta University	639	108	28	—
5. P.A. University of Technology, Madras	1059	44	30	—
6. Bombay University, Dept. of Chem. Tech.	301	—	118	—
7. Saugar University	517	—	51	—
8. Annamalai University	228	—	—	—
9. Nagpur University	246	—	26	—
10. M.S. University, Baroda	268	24	5	—
11. Cochin University	14	—	—	—
12. M.S.M. College of Engg., Jodhpur	22	—	—	—
13. BHU-IT	891	—	171	—
14. Roorkee University	2347	1360	352	2
15. Sri Venkateswara University, College Engg. Tirupati	65	—	4	—

	M.Tech.	P.G. Dip.	Ph.D.	M.Phil.
Non-Govt. Colleges				
1. N.I.E. Mysore	35	—	—	—
2. T.I.T. Bhiwani	24	—	—	—
3. H.B.T.I. Kanpur	227	—	7	—
4. V.J.T.I. Bombay	402	125	2	—
5. B.V.M. Vallabh Vidyanagar	101	—	1	—
6. P.S.G.C.T. Coimbatore	761	37	16	—
7. School of Planning, Ahmedabad	70	—	—	—
8. T.C.E.T. Patiala	22	28	—	—
9. S.G.S.I.T.S. Indore	94	—	1	—
10. L.M. College of Pharmacy, Ahmedabad	194	—	7	—
11. Walchand College, Sangli	85	—	—	—
12. Thiagarajar College of Engg., Madurai	74	—	—	—
13. B.I.T. Ranchi	108	—	32	—
Government Colleges				
1. Punjab Engg. College, Chandigarh	274	58	—	—
2. Bengal Engg. College, Howrah	256	58	—	—
3. Bihar Instt. of Tech., Sindri	37	8	—	—
4. C.I.T. Coimbatore	131	2	2	—

	M.Tech.	P.G. Dip.	Ph.D.	M.Phil.
5. L.D. College, Ahmedabad	127	—	—	—
6. Assam Engg. College, Gauhati	3	—	—	—
7. Puna Engg. College	362	—	—	—
8. Engg. College, Trichur	69	—	—	—
9. Delhi College of Engg., Delhi	93	—	2	—
Single Faculty Institutions				
1. S.P.A. New Delhi	557	—	—	—
2. N.I.T.I.E. Bombay	180	—	—	—
3. I.S.M. Dhanbad	56	42	25	7



ANNEXURE VI

DETAILS OF R & D ACTIVITIES

(For the 5 years ending 1977–78)

	Universities	Sponsored Research Projects	Consultancy Projects	Ph.D. Projects	M. Tech. Projects
		(1)	(2)	(3)	(4)
1.	Bombay	108	160	51	157
2.	P.A.U.T., Madras	72	41	25	245
3.	Jodhpur	1	many	4	21
4.	Tirupati	8	5	11	50
5.	Annamalai	2	3	1	65
6.	Kakinada (J.N. Tech. University)	—	5	5	9
7.	G.B. Pant	21	21	8	13
8.	Nagpur	3	4	7	96
9.	Andhra	39	22	29	184
10.	B.I.T.S. Pilani	67	—	12	121
11.	Baroda	25	12	6	142
12.	Aligarh	5	a few	11	90
13.	BHU-IT	97	many	100	195
14.	Osmania	2	14	10	109
		450		280	1497

	(1)	(2)	(3)	(4)
Regional Engineering Colleges				
1. Kurukshetra	3	264	19	87
2. Warangal	26	359	31	188
3. Calicut	19	33	3	21
4. Tiruchirappalli	11	32	12	59
5. Surathkal	13	12	8	120
6. Surat	14	40	7	43
7. Durgapur	7	8	19	74
8. Jamshedpur	2	2	3	24
9. Jaipur	7	9	13	38
10. Nagpur	6	34	18	126
11. Rourkela	11	8	18	72
12. Bhopal	22	43	21	152
13. Allahabad	7	51	17	154
	148	895	189	1158
Government Colleges				
1. Bangalore	1	—	—	13
2. Poona	5	20	4	101
3. Coimbatore	—	6	1	20
4. Trichur	12	9	—	41
5. Trivandrum	5	17	5	85
6. L.D.C. Ahmedabad	—	2	—	23

		1	2	3	4
7.	Jabalpur	1	4	6	58
8.	Gauhati	—	—	—	3
9.	Raipur	—	—	—	—
10.	Ranchi	4	9	16	45
11.	Howrah	6	30	20	80
12.	Chandigarh	4	79	3	79
13.	Delhi	1	4	10	64
		39	180	65	612
Non-Government Colleges					
1.	T.I.T., Bhiwani	—	—	4	16
2.	T.C.E.T., Patiala	—	5	2	15
3.	H.B.T.I., Kanpur	16	37	39	126
4.	V.J.T.I., Bombay	28	19	—	68
5.	S.G.S.I.T.S., Indore	7	29	17	54
6.	L.M.C. Pharmacy, Ahmedabad	6	—	10	50
7.	B.V.M. Vallabh Vidyanagar	2	5	2	18
8.	P.S.G.C.T., Coimbatore	31	27	18	108
9.	N.I.E., Mysore	—	—	—	10
10.	Thiagarajar College, Madurai	2	3	7	31
11.	B.I.T., Ranchi	12	17	8	32
12.	School of Planning, Ahmedabad	10	—	—	—
		114	142	107	528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ANNEXURE VII

PARTICULARS OF DOCTORAL RESEARCH PROJECTS

IITs. & II Sc.: 1978

	Ph.D. Strength (Engg.)	Out-turn
1. I.I.T., Bombay	318°	56
2. I.I.T., Delhi	227	51
3. I.I.T., Kanpur	146	60
4. I.I.T., Kharagpur	155	31
5. I.I.T., Madras	154	57
6. I.I. Sc., Bangalore	349	68
	1349	323

° This excludes research scholars funded by other agencies such as C.S.I.R., U.G.C. etc.

University Institutions

	Ph.D. Research Projects in Progress in 1977-78	Ph.D. Already Awarded in 5 years
1. P.A.U.T., Madras	13	11
2. J.N. Technical University, Hyderabad	9	—
3. Andhra University	31	3
4. Shri Venkateswara University	10	1
5. Annamalai University	—	1
6. Nagpur University	—	7
7. G.B. Pant University	7	—
8. Jodhpur University	7	4
9. Bombay University	25	31

		(1)	(2)
10.	Calcutta University, (Centre for Radio Physics)	22	2
11.	B.I.T.S., Pilani	26	11
12.	Jodhpur University	5	—
13.	Aligarh University	9	2
14.	BHU-IT	17	51
15.	Osmania	7	2
Regional Engineering Colleges			
1.	Kurukshetra	16	4
2.	Warangal	61	23
3.	Calicut	3	—
4.	Surathkal	9	—
5.	Tiruchirappalli	10	2
6.	Surat	7	2
7.	Jaipur	8	5
8.	Jamshedpur	3	—
9.	Durgapur	11	8
10.	Nagpur	8	2
11.	Rourkela	18	—
12.	Bhopal	18	2
13.	Allahabad	17	—
		189	48
Non-Government Institutions			
1.	T.I.T., Bhiwani	4	1
2.	T.C.E.T., Patiala	2	—
3.	B.I.T., Ranchi	6	2

4.	Thiagarajar College, Madurai	14	—
5.	C.I.T., Coimbatore	7	—
6.	P.S.G.C.T., Coimbatore	14	18
7.	B.V.M., Vallabh Vidyanagar	—	2
8.	L.M.C. Pharmacy, Ahmedabad	10	—
9.	S.G.S.I.T.S., Indore	11	5
10.	V.J.T.I., Bombay	6	1
11.	H.B.T.I.,Kanpur	20	3
		94	32

State Government Colleges

1.	Delhi	9	1
2.	Chandigarh	4	2
3.	Howrah	21	17
4.	Sindri	2	3
5.	Jabalpur	3	1
6.	Trivandrum	4	1
7.	Coimbatore	—	1
8.	Poona	4	—
		47	26


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ANNEXURE VIII

DOCTORATES AWARDED IN ENGINEERING AND TECHNOLOGY IN 1976-77

Engineering

1.	Engineering Mechanics	8
2.	Engineering Materials	15
3.	Electrical Engineering	5
4.	Generation	25
5.	Transmission	12
6.	Frequency Measurement	1
7.	Signals	3
8.	Microwave Electronics	1
9.	Semiconductor Devices	7
10.	Circuits	6
11.	Microelectronics	3
12.	Computers	4
13.	Radio & Radar Engg.	3
14.	Heat Engineering	2
15.	Heat Transfer	3
16.	Internal Combustion Engines	2
17.	Solar Energy	2
	Mechanical Engineering	
18.	Physical Principles	
19.	Machine Parts	
20.	Lubrication	
21.	Machine Tools	
22.	Refrigerants	1
23.	Fans & Pumps	2
24.	Convers	1
25.	Factory Operations	2
26.	*Mining Engineering*	3
	Civil Engineering	
27.	Foundation Engineering	22
28.	Soil Mechanics	5
29.	Structural Analysis	5
30.	Loads and Deformations	7
31.	Structural Design	26
32.	Bridges	2
33.	Highway Engineering	2
34.	Hydraulic Engg.	12
35.	Sanitary & Municipal Engineering	4
	Aeronautical Engineering	
36.	Aerodynamics	8
37.	Air Frames	2
38.	Engines, Fuels & Propellants	5
39.	Aircraft Instrumentations	1
40.	*Automobile Engineering*	1
41.	*Automatic Control Engg.*	1
42.	Control Theory	9
43.	Linear Systems	1
44.	Non-Linear Systems	3
45.	Sequential Machines	4
		229
	Technology	
46.	Chemical Technology	10
47.	Evaporation & Separation	3

48.	Mass Transfer	10
49.	Heat Transfer	7
50.	Named Reaction's	3
51.	Reaction Kinetics	5
52.	Heavy Chemicals	3
53.	Food Technology	3
54.	Ceramic Technology	2
55.	Dyes	3
56.	Plastic Technology	1
	Metallurgy	
57.	Electrometallurgy	2
58.	Ferrous Metals	7
59.	Non-Ferrous Metals	6
60.	Physical & Chemical Metallurgy	8
61.	Metallography	1
62.	Leather Technology	1
63.	Paper Technology	1
64.	Textile Technology	5
		81
65.	*Bio-Medical*	4
66.	*Public Health*	1
	Earth Sciences	
67.	Chemical Minerology	1
68.	Hydraulogy	6
69.	Stratigraphy	2
70.	Geochemistry	2
71.	Petrology	1
72.	Plutonic Rocks	2
		329

Institutions/Universities which awarded Ph. Ds. in 1976-77

1.	IIT Bombay	38	13.	Andhra	5
2.	IIT Delhi	28	14.	Poona	3
3.	IIT Kanpur	30	15.	Kanpur	3
4.	IIT Kharagpur	23	16.	Bangalore	3
5.	IIT Madras	66	17.	ISM Dhanbad	3
6.	II Sc Bangalore	38	18.	Pilani	2
7.	Bombay	16	19.	Punjab	2
8.	Roorkee	14	20.	Jodhpur	2
9.	Calcutta	8	21.	Kakatiya	2
10	Madras	7	22.	Indore	2
11.	Nagpur	7	23.	JN Tech. University, Hyderabad	2
12.	Jadavpur	7			

24.	Allahabad	2	33.	Meerut	1
25.	Banaras	2	34.	Osmania	1
26.	Rajasthan	1	35.	Delhi	1
27.	Ranchi	1	36.	Bhopal	1
28.	Shivaji	1	37.	Burdwan	1
29.	Venkateswara	1			— —
30.	Vikram	1			329
31.	Kalyari	1			— —
32.	Kashmir				


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ANNEXURE IX

DETAILS OF CONSULTANCY PROJECTS

IITs/II Sc.	Consultancy Projects in 1978
1. Kharagpur	80
2. Madras	197
3. Kanpur	103
4. Delhi	92
5. Bombay	272
6. Bangalore	87
	831

Category of Institutions	Consultancy Projects in five years ending 1977–78
1. 24 Universities	Data not available
2. 13 RECs.	895
3. 12 Non-Government Colleges	142
4. 13 Government Colleges	180
5. 3 Single Faculty Institutions	38


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ANNEXURE X

DETAILS OF CONTINUING EDUCATION PROGRAMMES

IITs/II Sc. (In 1977-78)

Name of the Institute	Symp./Conf. Institute Seminar Short-term courses	Conferences attended/ lectures delivered	No. of teachers/ Scholars under QIP/FIP
1. Bombay	56	126	21
2. Delhi	56	278	15
3. Kanpur	Many	—	51
4. Kharagpur	27	—	41
5. Madras	75	—	88
6. II Sc. Bangalore	40	157	28
			244

Universities (in 5 years ending 1977-78)

	Con. Education Courses	Seminars
	1	2
1. Andhra	6	90
2. Nagpur	1	—
3. Kakinada (J.N. Tech. University)	—	10
4. G.B. Pant	5	Many
5. Saugar	—	—
6. Shri Venkateswara	—	6
7. Jodhpur	3	—
8. Annamalai	—	—
9. P.A.U.T., Madras	80	Many
10. Bombay	18	—

	(1)	(2)
11. Pilani	7	—
12. Aligarh	—	—
13. BHU-IT	9	18
14. Osmania	10	14
	139	
Regional Engineering Colleges		
1. Allahabad	1	1
2. Bhopal	14	10
3. Rourkela	3	4
4. Nagpur	19	10
5. Jaipur	6	1
6. Jamshedpur	1	—
7. Durgapur	2	1
8. Surat	4	12
9. Surathkal	4	2
10. Tiruchirappalli	3	—
11. Calicut	10	1
12. Warangal	10	4
13. Kurukshetra	6	7
	83	53
Non-Government Colleges		
1. Thiagarajar Engg. College, Madurai	3	1
2. N.I.E., Mysore	—	—
3. C.I.T., Coimbatore	1	4
4. P.S.G.C.T., Coimbatore	22	3

	(1)	(2)
5. L.M.C. Pharmacy, Ahmedabad	—	—
6. S.G.S.I.T.S., Indore	11	9
7. T.I.T., Bhiwani	—	4
8. T.C.E.T., Patiala	—	—
9. V.J.T.I., Bombay	5	6
10. B.I.T., Ranchi	—	—
11. H.B.T.I., Kanpur	8	18
12. School of Planning, Ahmedabad	—	3
	50	50

State Government Colleges

1. Bangalore	—	—
2. Delhi	5	4
3. Chandigarh	3	21
4. B.E.C., Howrah	6	8
5. Sindri	1	3
6. Raipur	—	—
7. Gauhati	1	—
8. Jabalpur	—	6
9. Ahmedabad	1	—
10. Trivandrum	12	5
11. Trichur	2	2

12. Coimbatore	4	—
13. Poona	10	3
	45	52

Single Faculty Institutions

1. I.S.M., Dhanbad	58	6
2. N.I.T.I.E., Bombay (1977-78)	103	3
3. S.P.A., New Delhi	—	5
	161	14

ANNEXURE XI

LIST OF EMERGING AREAS

1. Acoustics Engineering
2. Agricultural Engineering
3. Aero Space Propulsion
4. Appropriate Technology
5. Automation
6. Biomedical Engineering
7. Bio Engineering
8. Bio Chemical Engineering
9. Bridge Engineering
10. Coal Processing
11. Construction Management
12. Cryogenic Engineering
13. Computer Sciences & Technology.
14. Coastal Engineering
15. Cloud & Rainfall Studies ; Flood Forecasting
16. Environmental Science & Engineering and Pollution Control
17. Energy Systems and Engineering.
18. Engineering Seismology
19. Ergonomy & Safety Engineering.
20. Extra High Voltage Technology
21. Entrepreneurship
22. Fertiliser Technology
23. Food Engineering & Technology
24. Forest & Wood Technology
25. Foundation Engineering
26. Fabrication Technology
27. Gas Turbine Engines
28. Hydrom etallurgy
29. Information & Communication Systems.
30. Impact of Technology on Environment
31. Informations & Data Processing
32. Irrigation Engineering
33. Industrial Minerals & Mineral Process Engineering
34. Integrated Rural Development
35. Laser & Laser Systems
36. Membrane Technology
37. Microwave Engineering
38. Missiles Technology
39. Military Vehicles Technology
40. Military Science & Engineering
41. Medical Electronics

42. Nutrition Science & Technology
43. Nuclear Power Engineering
44. Ocean Sciences & Engineering
45. Off-shore Structures.
46. Oil Hydraulics & Pneumatics
47. Polymer Engineering
48. Process Engineering
49. Process Techniques
50. Photogrametry
51. Photo Interpretation and Remote Sensing
52. Photonics Engineering (Opto Electronics & Electro Optics)
53. Pharmaceutical Sciences & Technology
54. Reliability Engineering
55. Resources Engineering
56. Recycling and waste Utilisation Technology
57. Rural Communications, Rural Transport, Rural Housing.
58. Railway Engineering
59. Switchgear Engineering
60. Space Technology
61. Transportation Engineering
62. Tribology
63. Textile Engineering & Technology
64. Welding
65. Water Resources Development
66. Water Management

This list is only illustrative.

ANNEXURE XII

THE EXISTING NORMS (APPROVED IN LATE SIXTIES) FOR PROVIDING ASSISTANCE TO INSTITUTIONS CONDUCTING/INTRODUCING POST-GRADUATE COURSES IN ENGINEERING AND TECHNOLOGY.

P. G. Degree Course

Non-recurring :

(i)	Building	Nil (only in exceptional cases assistance is given).
(ii)	Equipment	Rs. 1.5 lakhs per course.
(iii)	Library	Rs. 10,000 for less than 3 courses. Rs. 30,000 for 3 or more courses.

Recurring :

(i)	Teaching staff	1 Professor, 1 Asstt. Professor.
(ii)	Supporting staff	15% of the expenditure on teaching staff (excluding Class IV staff).
(iii)	Maintenance Expenditure	Rs. 500 per student per year (revised to Rs. 1000 per student per year in June'72).
(iv)	Scholarships	Rs. 250/- p.m. per student for a period of 24 months. (revised to Rs 400/- p.m. per student in May 1975).
(v)	Library	Rs. 5000 for less than 3 courses. Rs. 10,000 for more than 3 courses.

P. G. Diploma Course

Financial assistance may be provided as recommended by Visiting Committee/P. G. Board.

At its meeting held on 30th April 1976, the Expenditure Finance Committee recommended revision of these norms as under :-

> The ceiling for equipment, Library and building etc. should be estimated at the rate of Rs 3 lakhs per course. However, the exact amount may be worked out by the Visiting Committees taking into consideration the nature of the course and the existing facilities in a particular field.


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ANNEXURE XIII

REVISED NORMS RECOMMENDED BY THE NAYUDAMMA COMMITTEE FOR PROVIDING ASSISTANCE TO INSTITUTIONS CONDUCTING/ INTRODUCING POST-GRADUATE COURSE IN ENGINEERING & TECHNOLOGY

FULL TIME P.G. DEGREE COURSE

Non-recurring :

(i) Building	Based on essential needs assessed by Visiting Committees.
(ii) Equipment (including furniture)	Ceiling of Rs. 5 lakhs per course mainly for core facilities. Actual requirements to be assessed by visiting Committees. In exceptional cases, an additional ceiling of Rs. 2 lakhs for specific facilities based research proposals of relevance. A provision of Rs. 5 to 15 lakhs for a mini computer where it is not available
(iii) Library	Rs. 10,000 per course subject to a maximum of Rs. 40,000 for more than 4 courses for books, back volumes etc. An outright grant of Rs. 1 lakh for Xerox machine, micro-film recorder etc. wherever these facilities are not available. Library space of atleast 2000 sq.m. for a total student population of one thousand (including undergraduates).

Recurring :

(i) Teaching Staff	1 Professor, 1 Asstt. Professor/Reader Rs. 5,000 per year per course for payment to Visiting Professors/Experts at the rate of Rs. 100 per lecture.

		Rs. 5,000 per year per vacant post-graduate faculty position for payment to Visiting Faculty/Experts from outside.
(ii)	Supporting staff (including Class IV staff, if necessary)	20% of the notional expenditure on sanctioned teaching staff (not on actual expenditure on staff in position).
(iii)	Maintenance Expenditure	Rs. 3000 per student per year. (Rs. 4000 per student per year for a maximum of 3 years for doctoral candidates).
		The research scholars may be allowed, if necessary, to attend conferences/seminars within the country using the money from the contingency/maintenance grants. Such expenses should not exceed Rs. 750 per year for an ME/MTech student and Rs. 1000 per year for a doctoral candidate.
(iv)	Scholarships	Rs. 600/- p.m. per student for a period of 3 semesters(18 months). Rs. 450/- for sponsored candidates getting full salary. Rs. 700, Rs. 800 and Rs. 900 p.m. for the first year, second year and third year respectively for doctoral candidates. The fellowship to be enhanced by Rs. 50/- after submission of thesis and to be continued for 3 months or till the viva is over, whichever is earlier.
(v)	Library	Rs. 10,000/- per course subject to a maximum of Rs. 30,000 for more than 3 courses for books, journals etc.

Recommendation of grants for any post-graduate programme should be based on the overall post-graduate activities of the departmenrs concerned and not on a narrow truncated basis of specific post-graduate course/courses proposed by an institution.